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LIFE CHANGES ON THE GLOBE.

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An assemblage of facts concerning any branch of Nature's operations cannot fail to interest an intelligent being; but they do not constitute a science until they are arranged and co-ordinated, so as to mark the ascent from particular, to general, or universal truths, and thus contribute to that speculative philosophy which constitutes the noblest triumph which the human intellect can achieve. Regarded in this light, departments of physical inquiry are interesting in proportion to the amplitude of the views which they disclose, or in other words in proportion to the number and variety of special facts which they are able to refer to simple principles, or comprehensive laws. Modern discoveries concerning the correlation and conservation of forces show us the purely artificial character of the divisions which the limitation of our faculties compels us to make, and point to the conclusion that all spheres of activity, all realms of space would only exhibit the phenomena of a single science to a mind capable of grasping the majestic whole. In the direction of this goal, man, as the child of Time and the heir of Immortality, feels that he is progressing. It may be, probably must be, for ever afar off, and impossible to attain, but when we deal with infinities, an approach may be constant, a boundary never reached.

Among the sciences which at the present time exercise the profoundest influence upon the diligent searcher, and the casual collector of the golden particles of truth, geology must claim a noble rank, and although—dating its progress in time—it is one of the shortest of the many rivers of knowledge, it has become one of the broadest and richest through the confluence of a thousand tributary streams. At a very early period of its brief career, it connected the changes in the structure of the globe, with successive scenes of animated life, and extended the domains of what is commonly called "natural history," and other biological sciences, from the limited present to the im-

mense, and incalculable, ages of the past. The natural arrangement of various strata necessitated the idea that some were ancient, and others comparatively new. The same fact of sequence in formation was testified by their structure, some being obviously composed of materials obtained from those of earlier date; but the various leaves of the great earth-book would have been comparatively blank pages, if they had not been written over with the hieroglyphic characters of once living beings. It was soon found that fossils, which some early observers thought to have been only freaks of Nature's "plastic power," were the most important records of terrestrial modification. Particular kinds were ascertained to have been connected with particular periods of the history of any locality which presented a succession of forms. Up to a certain point similar remains were discovered in analogous formations in different countries, and it was assumed that we were thus in possession of the means of establishing a comparative chronology universally applicable in our mundane world. The age, for example—giving geological latitude to the word—of Silurian slates and sandstones, coal measures, or chalk, was supposed to be the same all over the globe. If the characteristic fossils were found, they were presumed to decide the epoch to which the strata belonged, and few geologists, even in the recesses of their own minds, ventured to question the dogmas of a scientific orthodoxy which were not without convenience in application, and which were widely received. To Professor Huxley belongs the honour of boldly assailing the ground of this belief, and of recalling the whole tribe of stratigraphical decipherers to a just consideration of the wide distinction between facts arrived at through the genuine processes of inductive or deductive investigation, and the various fancies and figments by which men delude themselves into the notion that their knowledge extends to regions which in reality their inquiries have failed to reach.

Human egotism has been at the bottom of many speculative errors, and man has too often tried to dwarf the universe so as to bring it within the limits of his feeble faculties, and make its operations correspond in brevity of duration with the shortness of his mortal life. It is to this source that we owe many follies of cosmogony and geology, and it is very rarely that even the professed investigators of science can be induced to forego the idle effort to explain the history of our planet by theories prodigal in violence and parsimonious in time. From all such blunders English geologists, at least, might have easily emancipated themselves if they had followed to their legitimate conclusions the principles established by Sir Charles Lyell in his masterly examination of the connection between past facts

and existing causes; but, notwithstanding the exhaustive reasonings which that distinguished philosopher embodied in a most fascinating style, it has been customary to represent the earlier epochs of our globe as periods of such continuous violence as to make us exclaim with Isabel, "nothing but thunder," and it has also been common to exalt negative evidence to a most unwarrantable position in the scale of proof. To get the world made and unmade as quickly as impatient professors desired, it was necessary to fancy that, comparatively speaking, no great while had elapsed since it "wandered lonely as a cloud" in the nebulous form. Condensation followed almost as rapidly as the drops fall from the condensed steam of the locomotive, and it spun round as a fluid fiery mass, getting sufficiently crusted at the surface to be a convenient lodging for such forms of life as require what the gardeners call a strong "bottom heat." Radiation enabled more and more of the molten material to become solid, and colder creatures appeared upon the scene. Still the central fires maintained their sway, every volcano was their outlet, and where no lava streams could burst forth, continents were upheaved with all the facility which characterizes the elevation of bubbles on the surface of a baking pie. These high-pressure movements soon exhausted and absorbed successive races of organized existences, and when the earth had been tossed and tumbled about, so that "chaos was come again," a fresh exertion of creative energy upraised new forests, and caused new creatures to bound or crawl beneath their shade. One apparent advantage of this school of geology was its supposed power to exhibit the first dawn of life, and the successive catastrophes by which systems were swept away, and a higher *fauna* and *flora* convulsively introduced. The general results of this mode of philosophizing are thus stated by Professor Huxley, the words in brackets being added by ourselves.*

"Animals and plants began their existence together, not long after the commencement of the deposition of the [earliest known] sedimentary rocks, and then succeeded one another in such a manner that totally distinct faunæ and floræ occupied the whole surface of the earth, one after the other, and during distinct epochs of time.

"A geological formation is the sum of all the strata deposited over the whole surface of the earth during one of these epochs; a geological fauna or flora is the sum of all the species of animals or plants which occupied the whole surface of the globe during one of these epochs.

"The population of the earth's surface was at first very similar in all parts, and only from the middle of the Tertiary epoch onwards began to show a distinct distribution in zones.

* *Quarterly Journal of the Geological Society*, May 1862.

"The constitution of the original population, as well as the numerical proportions of its members, indicates a warmer and, on the whole, somewhat tropical climate, which remained tolerably equable throughout the year. The subsequent distribution of living beings in zones is the result of a gradual lowering of the general temperature, which first began to be felt at the poles.

"It is not now proposed to inquire whether these doctrines are true or false; but to direct your attention to a much simpler though very essential preliminary question—What is their logical basis? what are the fundamental assumptions upon which they all logically depend? and what is the evidence on which those fundamental propositions demand our assent?

"These assumptions are two: the first, that the commencement of [that part of] the geological record [which has hitherto been deciphered] is coeval with the commencement of life on the globe; the second, that geological contemporaneity is the same thing as as chronological synchrony. Without the first of these assumptions there would of course be no ground for any statement respecting the commencement of life; without the second, all the other statements cited, every one of which implies a knowledge of the state of different parts of the earth at one and the same time, will be no less devoid of demonstration.

"The first assumption obviously rests entirely on negative evidence. This is, of course, the only evidence that ever can be available to prove the commencement of any series of phenomena: but, at the same time, it must be recollected that the value of negative evidence depends entirely on the amount of positive corroboration it receives. If A B wishes to prove an *alibi*, it is of no use for him to get a thousand witnesses simply to swear that they did not see him in such and such a place, unless the witnesses are prepared to prove that they must have seen him had he been there. But the evidence that animal life commenced with the Lingula-flags, *e.g.* would seem to be exactly of this unsatisfactory uncorroborated sort. The Cambrian witnesses simply swear they "haven't seen anybody their way;" upon which the counsel for the other side immediately puts in ten or twelve thousand feet of Devonian sandstones to make oath they never saw a fish or a mollusc, though all the world knows there were plenty in their time."

Having thus defined the nature of his inquiry, Professor Huxley shows that when the lias of England and that of Germany, or the cretaceous rocks of Britain or of India are said to be "contemporaneous," the word is most loosely employed, and that no evidence exists by which synchronism of formation can be demonstrated in either case. Taking for an illustration the computation of the late Daniel Sharpe that thirty or forty per cent. of the known Silurian mollusca are common to both sides of the Atlantic, and by way of allowance for undiscovered specimens, assuming that sixty per cent. are common to the North American and British Silurians, he avers that if contem-

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poraneity or synchronism were assumed upon such evidence, we should fall into serious mistakes:—

"Now suppose that, a million or two years hence, when Britain has made another dip beneath the sea and has come up again, some geologist applies this doctrine, in comparing the strata laid bare by the upheaval of the bottom, say of St. George's Channel, with what may then remain of the Suffolk Crag. Reasoning in the some way, he will at once decide the Suffolk Crag and the St. George's Channel beds to be contemporaneous; although we happen to know that a vast period (even in the geological sense) of time, and physical changes of almost unprecedented extent, separate the two.

"But if it be a demonstrable fact that strata containing more than sixty or seventy per cent. of species of Mollusca in common, and comparatively close together, may yet be separated by an amount of geological time sufficient to allow of some of the greatest physical changes the world has seen, what becomes of that sort of contemporaneity the sole evidence of which is a similarity of facies, or the identity of half a dozen species, or of a good many genera?

"And yet there is no better evidence for the contemporaneity assumed by all who adopt the hypotheses of universal faunæ and floræ, of a universally uniform climate, and of a sensible cooling of the globe during geological time."

Looking fairly at the evidence before us, we can only come to the conclusion that "a Devonian fauna and flora in the British Islands may have been contemporaneous with Silurian life in North America, and with a carboniferous fauna and flora in Africa." What *was* the case we have as yet no means of knowing, and while grounds of decision are wanting, judgment should hold suspense. If we may compare the successive changes in various parts of the globe to the movements of a clock, we must not assume the starting-point of any series of operations to have been identical. Each country, so to speak, may have had its own clock—all the clocks going upon the same principle, and to a large extent with the same order in their motions, but the dawn marked by one may correspond in actual time with the noon on the evening of another place.

The extreme value so often assigned to negative evidence has materially assisted spasmodic theories. It has led to the unproved and improbable assumption that our very limited search for the remains of older periods enables us to decide authoritatively the proximate periods at which fish, reptiles, or mammals were introduced, and it has also induced many authorities to affirm in the most positive manner that the organized beings of two epochs have been *totally* distinct. As an instance of this common phraseology we may cite Professor M'Coy's declaration that in Australia as in Europe "the greater part of the country sank under the sea during the Tertiary period,

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and *every trace* of the previous creations of plants and animals were destroyed, and replaced by a *totally different set.*"* We shall see how far this violence of expression is justified by Professor Huxley's investigations; but before dismissing the subject of negative evidence, let us call to mind Sir C. Lyell's remarks in 1851,† in reference to the dredging operations of Messrs. Forbes and MacAndrew between the Isle of Portland and the Land's End. During one hundred and forty dredgings, at various distances from the shore, they obtained a large quantity of marine invertebrates, but very few traces of vertebrate life, none of them referable to terrestrial animals. "If," says Sir Charles, "reliance could be placed on negative evidence, we might deduce from such facts, that no cetacea existed in the sea, and no reptiles, birds, or quadrupeds on the neighbouring land."

In comparing the fauna and flora of the two periods, or of two contemporaneous countries, the amount of agreement or difference which an observer will trace must depend very much upon the method he employs. If he is a profound believer in certain systems of classification, he may affirm objects to be totally distinct, or new creations, and so forth, while they are closely allied; and if we consider the pernicious influence of spasmodic theories in blinding the mind even to obvious facts, it is consoling to find so great an authority as Professor Huxley confirming opinions which are in conformity with the most probable deductions from general science. He tell us that, if we leave negative differences out of consideration, and regard the fossil world in the broad spirit suggested by comparative anatomy, we shall be struck with "the smallness of the total change." Out of "two hundred known orders of plants, not one is certainly known to exist exclusively in a fossil state. The whole lapse of geological time has as yet not yielded a single new ordinal type of vegetable structure." In the animal world the change has been greater; but still "no fossil animal is so distinct from those now living as to require to be arranged even in a separate class from those which contain existing forms. It is only when we come to the orders, which may be roughly estimated at about a hundred and thirty, that we meet with fossil animals so distinct from those now living as to require orders from themselves; and these do not amount on the most liberal estimate to more than about ten per cent. of the whole." The Protozoa, it appears, have not lost any known order, the Cœlenterata but one, the rugose corals—the Mollusca none, the Echinoderms three, and the Crustacea two, "making altogether five for the great subkingdom of Annulosa. Among vertebrates there is no ordinally distinct fossil fish: there is

* *Annals of Natural History*, Feb. 1862, p. 144.
† *Quarterly Journal of the Geological Society*, May 1851, p. 53.

only one extinct order of Amphibia, the Labyrinthodonts; but there are at least four distinct extinct orders of Reptilia, viz. the Icthyosauria, Plesiosauria, Pterosauria, Dinosauria, and perhaps another or two. There is no known extinct order of birds, and no certainly known extinct order of Mammals, the ordinal distinctness of the 'Toxodontia' being doubtful:"—

'The two highest groups of the Annulosa, Insecta and Arachnida, are represented in the Coal either by existing genera or by forms differing from existing genera in quite minor peculiarities.

"Turning to the Vertebrata, the only palæozoic Elasmobranch Fish of which we have any complete knowledge is the Devonian and Carboniferous *Pleuracanthus*, which differs no more from existing Sharks than these do from one another.

"Again, vast as is the number of undoubtedly Ganoid fossil Fishes, and great as is their range in time, a large mass of evidence has recently been adduced to show that almost all those respecting which we possess sufficient information are referable to the same subordinal groups as the existing *Lepidosteus*, *Polypterus*, and Sturgeon; and that a singular relation obtains between the older and the younger Fishes; the former, the Devonian Ganoids, being almost all members of the same suborder as *Polypterus*, while the Mesozoic Ganoids are almost all similarly allied to *Lepidosteus*."

With these facts before us, how are we justified if we retain the phraseology of the scientific *convulsionnaires*, or impute to the operations of nature, jerks, cataclysms, and violence, which are not evidenced by external facts, and which are highly improbable upon *à priori* grounds?

It is curious that the theories of spasmodic geology have readily allied themselves with development speculations, which, if valid in any shape, must demand such enormous periods of time, and such gradual processes of modification, as to have more real affinity with the philosophy that Lyell has traced. In common with most other physiologists, Professor Huxley comes to the conclusion that "positive evidence fails to demonstrate any sort of progressive modification towards a less embryonic or less generalized type in a great many groups of animals of long-continued geological existence." In such groups he finds abundant evidence of variation—none of what is ordinarily understood as progression," and he adds, "if the known geological record is to be regarded as even any considerable fragment of the whole, it is inconceivable that any theory of a necessarily progressive development can stand." If, however, the plan of creation involves progressive modification, then even what we commonly understand by "geological eras" will appear brief spaces of time when compared with the enormous periods during which modifications have taken place, and "the conclusion will inevitably present itself that the

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Palæozoic, Mesozoic, and Cainozoic faunæ and floræ, taken together, bear somewhat the same proportion to the whole series of living beings which have occupied this globe, as the existing faunæ and floræ do to them."

Serious difficulties are experienced when it is attempted to convert geological into historical time; but the periods required for even minor changes in the earth's surface must greatly exceed those with which the records of human civilization have to deal, and no geologist of repute would contend that a small number of ages would suffice for the deposition of any considerable thickness of sedimentary rock, or for the denudation of an extensive area by aqueous and atmospheric action. When, therefore, we contemplate an epoch in the physical history of the globe, we must beware of assigning limits upon imaginary grounds; and if on the one hand we accept Professor Phillips's caution, to avoid random speaking about "millions on millions of ages," we must at any rate be equally on our guard lest we condemn ourselves to an erroneous mode of interpretation by refraining from the perception of the fact that the operations which geology traces could not possibly have taken place within any duration that our faculties enable us to appreciate. In astronomical distances our understanding is soon brought to a condition in which the multiplication of figures fails to produce a corresponding enlargement in our ideas, and we must not expect more success in the attempt to grasp the ages of the earth. Taking the whole group of statified rocks in the British Isles at 100, Professor Phillips assigns 79 to the Palæozoic, 18 to the Mesozoic, and 3 to the Cainozoic; and if the thicker formations absorbed a proportionably greater length of time, it would not be easy to imagine calculations that would transcend the truth. Life changes on the earth can only be imperfectly understood from the incomplete series of remains that have been discovered, but from them the authority last cited computes the rate of progressive change at $\frac{1}{79}$ for the Palæozoic $\frac{1}{18}$ for the Mesozoic, and $\frac{1}{3}$ for the Cainozoic time, and he adds, "The slowness of early changes has been ascribed to a greater uniformity of terrestrial temperature than is now experienced."

How and in what manner climates have altered is too large a question to be treated incidentally; but, in connection with the present inquiry, we may quote some remarks of Mr. Hopkins, which cut off the recourse to central fires and rapid refrigeration as causes which produced noticeable effects in a few thousands or a few millions of years. "The part of the superficial temperature due to primitive heat is very small, amounting to about one-twentieth of a degree of Fahrenheit. It must have been constantly diminishing for an immense

period of time, and has now approached so near its ultimate limit, that if the earth's refrigeration should continue under the same natural conditions as at present, it would require, as shown by Poisson, the enormous period of a hundred thousand millions of years to reduce this small fraction to half its actual value. . . . . We are, however, more immediately concerned with past than with future changes. We should not be justified in supposing from what I have stated respecting the slow future variations of the earth's superficial temperature, that it has been equally slow for an equal period of past time; but it is still highly probable that some millions of centuries must have elapsed since the mean superficial temperature could have been greater by a single degree than at present, from the operation of the causes we are now discussing."* Changes in climate within the periods we trace, are to be accounted for as the results of varying configurations of land and water very gradually and slowly produced. They must have been important agencies in modifying the life upon the globe, but if ever the laws regulating the succession of animated beings are to be understood, the explanation must come from biological inquiries; and until physiology and kindred sciences have entered into their deductive stage, it is not probable that the question of the Origin of Species will be definitively solved.

As is usually the case with reformers, whatever may be the sphere of their labours, Professor Huxley neither stands alone in the opinions which he has enunciated, nor has he risen abruptly to be the pioneer of a new process of inquiry. As he himself remarked, others had felt similar difficulties, and cherished similar thoughts. He, however, has given clear and distinct utterance to what they hesitated to state, and although we think a few inaccuracies of expression occur in his admirable paper, further consideration only deepens the conviction produced upon all who were so fortunate as to hear the address delivered, that it exhibits that rare combination of the faculty of reasoning with ample knowledge of detail, which characterizes a work destined to be a landmark in the search for truth.

* *Quarterly Journal of the Geological Society*, February 1852, p. 59.

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BEAUTIFUL EXOTIC BEES.

BY H. NOEL HUMPHREYS.

As will be seen by the species represented in the accompanying plate, some of the exotic bees are almost as richly coloured as the more gaudy butterfly tribe, and at the same time are of such conspicuous size as must render them very remarkable objects, winging their rapid and always musical passage among the exuberant vegetation of the tropics. A thoughtful spectator seeing for the first time in their native wilds these gigantic and magnificently tinted bees, robbing the nectaries of tropic flowers of sweets whose mere perfume seems almost too delicious, could scarcely forbear picturing to himself the produce of unknown kinds of honey, of a luscious sweetness and exquisite flavour, as yet undreamed of. If, (he might reflect) those mean little plants of wild thyme, trailing their humble stems among the scanty herbage of our bleak northern hills, can yield delicious honey to that poor little brown gatherer, the old hive bee, what may one naturally expect to be the result of honey-gathering by such a noble race of bees as these of the tropics, and with such exquisite flowers to gather from! Such might easily be conceived to be the exclamation of an observer of the flight of bees among the gorgeous plants in one of the natural gardens of some intertropical valley; and he would think of those bees mentioned by Amer which make natural hives of the cavities of rocks, laying up honey in large pouches, or cells, of the size of a pigeon's egg, and which being dark coloured, and hanging to the sides of the hive in clusters, look like bunches of delicious grapes, containing, in fact, a juice far more sweet:* he might think also of what Clavigero, the Spanish historian of Mexico, says of a bee, evidently of a nearly allied species, which abounds in Yucatan, and produces the famous honey of Estabentiem, the finest in the world, which is said to be taken from the bees every two months. These bees are, however, small inconspicuous creatures, evidently belonging to the same group as our own honey hive-bee, though distinguished from it by being stingless.

The most magnificent bees are, on the other hand, not of the true honey kind. They belong principally to the class of solitary bees, including a few of the humble-bee class and their relatives. These last, though it is true that many of them of the "social" kinds *do* collect honey, yet manipulate it in a very inferior manner to that of the hive-bee. Other kinds only collect pollen, which being exclusively intended as

* In wild hives of this kind, Captain Basil Hall found comb of the usual size made as cells for the larvæ.

food for the young larvæ, is generally rolled into little balls, or pills, one being placed in each of the cells in which an egg is to be deposited, so that the infant larvæ may find food ready prepared for immediate consumption; but very little is accurately known with regard to the preparation of the food for the infant bees. It is probable that different kinds of food are prepared for the different sexes; so that in the case of the social bees, in whose community there is a third, or neutral sex, and in some, a second kind of female, three or four different sorts of food may be prepared, just as cells of a distinctly different size are constructed for the males, females, and neuters. The influence of the peculiar food is no doubt very essential; and indeed some entomologists have supposed that all the larvæ are, while in that stage, perfectly neutral, the sex being eventually determined by the kind of food upon which they are fed.* Under the influence of this view of the subject, it has been asserted that a peculiar kind of honey prepared expressly to feed the larva destined to become a queen, or foundress bee, will, if given to another larva, not originally intended to become a queen, cause that other larva to develop itself into a queen; although, if fed upon the food usually prepared for it, it would have remained a neuter. Such is the wonderful power attributed to this "royal jelly," as the prepared queen-food has been termed. The feeding of a neuter with the royal food is a course which some have supposed (on perhaps insufficient grounds) to be resorted to in cases where the queen bee of a hive has died, or been accidentally destroyed. A larva is then selected, it is said, from among the cells of the neutral larvæ, neutral larvæ having been proved by dissection to be imperfect females, and fed upon the royal jelly, the cell being enlarged to suit the size of a queen, for whose bulk a cell originally constructed for a male, or a worker would be insufficient. Some of the handsomest of the exotic bees are parasites and, consequently, not either honey or pollen-meat producers. Some, however, of those which are at present assigned to this idle and worthless class may, with increased knowledge of the subject, be found to have been unjustly treated in being classed among parasites, and have eventually a place assigned to them among their more respectable confrères the harvesting bees.

The ground upon which the fiat of parasitism has been pronounced against certain bees, is founded upon peculiarities in their anatomical structure; such, for instance, as the absence of the large flattened hollow in the tibia of the hind leg, which appears absolutely necessary to the honey carrier. Among the andrenidæ, however, the genus prosopis, though destitute of the

* This view seems, however, inconsistent with the known fact, that the female bee only deposits certain eggs in certain cells, and not elsewhere.

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usual apparatus for collecting honey, has been recently proved a honey producer nevertheless. Its nest has been discovered in tubes formed in the main stems of the bramble; and in the nest, filmy cells containing liquid honey. In the sub-family "acutilingues," also, the genus Sphecodes, though without the usual polleniferous organs, and consequently thought to be parasitic, has been watched by that indefatigable entomological observer Mr. F. Smith of the British Museum, while in the act of forming its burrow; an act which appears to afford conclusive evidence in favour of the non-parasitic habits of this genus of bees. Thus, some of the splendid foreign bees which have been pronounced parasitic on grounds similar to those above described may yet prove to be honey-makers, or at all events pollen collectors. Among the most conspicuous of the fine exotic bees figured in the annexed plate, is the truly splendid insect Xylocopa nobilis (No. 6), not one of the wood-boring, or carpenter bees, as they have been termed. This fine insect was captured by Mr. Wallis in the island of Celebes, an almost unknown collecting ground, from whence we may hope to receive many others new and splendid additions to our lists of exotic insects. The body of this fine bee is of the richest conceivable velvet black, bearing a rich brown bloom upon it—this deep ground colour is banded with transverse stripes of the richest gold colour—the two central stripes having a peculiarly bright and sparkling effect from their extreme narrowness. The wings are semi-opaque, and their colour modulates from a deep indigo-violet in the centre to a rich bronzy green at the extremities; the violet becoming nearly crimson where the wings join the body.

The terms, carpenter bees, upholsterer bees, mason bees, etc., which are, it must be owned, somewhat fanciful, were invented by the ingenious and indefatigable French naturalist, Réaumur, who intended by such names to convey the idea that his "carpenter bees" worked in wood, his "mason bees" in stone, or with stony cement, etc.

The amount of carpenter's work done, however, by the bees of the genus Xylocopa, a scientific term which conveys the same meaning as the popular name, consists merely in boring, or otherwise forming a burrow in wood; within which are formed separate cells, each destined to receive an egg, and a certain quantity of food for the young larva; some species sealing up the entrance with a cement formed of clay and a glutinous secretion mixed with it by the bee, as a security against the entrance of parasites. The carpenter bees do not live in communities, but in solitary pairs—the female doing all the carpenter work, and, as it would seem, every other kind of work also; the male leading a life of indolent pleasure. Nearly

all the exotic bees of the genus Xylocopa are remarkably handsome. A new species from India, figured at No. 5 in the plate, is perhaps handsomer than the one just described. It is true that the unusually slender and elongated body is entirely black, but then the wings exhibit the most gorgeous iridescent colours that can be conceived. They are of a reddish tawny bronze at the ends, getting redder towards the centre, where the red suddenly but softly blends into a rich metallic green, followed by a portion of rich deep blue, which in its turn becomes violet at the base of the wings. This species has not yet been named, but some such name as iridipennis, rainbow-winged, might not be inappropriate in allusion to their rich prismatic effect, and at the same time showing its affinity to an allied species which has been recently named fulgidipennis, or fulged-winged.

Centris flavopicta, No. 1 in the plate, is a very beautiful bee belonging to another genus. It is one of the many fine insects recently received from an energetic collector on the banks of the river Amazon. This is another new species which, though named, has never before been figured. It is indebted for its specific name to the subdued yellow tone of the abdomen and legs—the latter being finely painted or marked with patches of dark brown.

Oxæa flavescens, No. 2 in the plate, is a remarkably brilliant insect, to which no engraving or painting can do the slightest justice. The abdomen is of the richest metallic orange, of the greatest richness, but entirely without gloss, striped transversely with bands of pale glittering yellow, which have the appearance of positive bands of the most highly burnished pale gold.

No. 3, Euglossa analis, is one of the pretty and gaily-coloured small bees of the Brazilian forests, which have been often described before; but few of the more recently discovered species surpass this one in brilliant metallic tinting. No. 8, Euglossea Brullei is another species of the same genus; as well as No. 7, Euglossa violacea, the rich violet colour of which offered the artist a tempting contrast to the orange and yellow tones of the other specimens, or, as a third well-known species of Euglossa, it would hardly have found a place in our plate.

There is, however, yet another species of Euglossa which claims a place, not only on account of its beauty, but also for its novelty—being a very recently discovered species, and one never figured till it made its appearance in the present plate. This exquisite insect, to which the most highly-finished representation would do but scanty justice, was purchased from a rich collection of Brazilian insects lately received. It has been distinguished by Mr. F. Smith, the well-known author of the Museum Catalogue of Hymenoptera, by the appropriate

specific name "pulchra" (No. 4). The colour of the "face" is rich metallic apple green, contrasting finely with the ruddy brown of the large eyes. The thorax is of the finest velvety purple, appearing deep black in the parts which do not receive a direct light. The two upper segments of the abdomen are of a bright red violet, inclining to crimson; the remaining segments being of a vivid metallic straw colour, resembling the colour of electrum—that is to say, gold paled by an admixture of silver, a natural combination anciently found in the sands of the celebrated Pactolus, and from which some of the most ancient gold money of Sardis was coined. This new Euglossa is certainly the most beautiful of the genus, and at the same time the largest.

Many other exotic bees of very remarkable appearance might be described; some of the genus Chrysantheda being perhaps more beautiful than any insect figured in our plate. But in looking over various collections, the *embarras de richesses* became at last so great, that perhaps the very best choice was not always made. However, to choose eight as the most beautiful, out of several hundreds, was no easy task; yet, the selection may fairly be accepted as pretty complete for its extent.

A drawing, made at the same time, of another very fine bee (Centris denudans) is, however, now lying before me, which I may briefly describe, as our last specimen of Bee beauty. It is indeed extremely interesting on account of its curiously close resemblance to one of the great bee-flies described in a former paper, and is one of the very largest of the bee family. It has semi-opaque brown wings, a deep brown abdomen, and the legs are of the same colour; but the thorax is covered with a rich fur, resembling a deep plush velvet of a rich glossy tone, which might be defined as scarlet-brown, taking a flash of orange in a strong light.

The dipterous insect which so closely resembles it, even in its large size, is asilus ardens, which, even to the colour and character of the fur of the thorax, is so like the bee as to be easily mistaken for it at the first glance. This bee was received from the river Tapajos, a branch of the Amazon; and the great bee-fly, its counterpart, was taken near Para, not far distant—so that there is but little doubt that they will eventually be found together; the fly counterpart being, possibly, a parasitic attendant on the bee.

THE ART OF ELECTRO-PLATING AND GILDING.

BY RICHARD BETHELL.

It often occurs in the experience of collectors of coins, medallions, and works of art, that when *originals* are not to be had, models, facsimiles, and casts must be substituted; and in order to render them perfect, it is in very many instances desirable to finish them by a coating of silver, gold, or some other metal.

In most cases where gold and silver are thus applied, the impression will probably be first taken in copper by the electrotype, or in fusible metal by casting. But whatever method may be adopted for producing the first impression, the process of plating or gilding will be in each case the same, so that the production of the cast need not be further alluded to, except to note that, when the cast is taken in some non-metallic material, the operation becomes a little more complicated, as we shall presently see.

I purpose in this paper, giving somewhat minute details of the processes most generally approved, so that those unacquainted with the art may not meet with any difficulties which shall appear to them insurmountable; and I would strongly recommend all those who are making first attempts, to operate only on small articles; for, apart from the consideration of the convenience arising out of the use of light and portable apparatus, we have also to consider the question of cost, the materials used being expensive. When we remember that every pinch of oxide of silver that is used contains $\frac{108}{116}$ of pure silver, while the oxide of gold contains as much as $\frac{197}{216}$ of the noble metal, it will be sufficiently obvious that when we speak of using these oxides it is pretty nearly equivalent to speaking of so much pure gold and silver. Hence arises the necessity also of certain forms of battery apparatus by which the quantity of these costly materials is diminished, and every possibility of waste prevented.

As the plating and gilding processes are for the most part applied to *metallic* articles, and because they are much more readily covered by this means than non-metallic surfaces are, we will deal with them exclusively at first. Metals being good conductors of electricity, the labour of rendering them conductuous is unnecessary. It will soon be discovered by the experimenter that few difficulties present themselves in his efforts to obtain a deposit on his medallions or other objects; but on the other hand, he will discover by more mature experience, that his deposits are not equally firm and permanent. As a rule, he will find that when his surfaces are *perfectly clean*,

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his deposits will appear almost to enter the pores of the metal deposited upon; while if his surfaces are contaminated with grease, or with metallic oxide, although he may obtain a deposit to all appearance most satisfactory, it will be found to consist of a mere shell covering his mould, which, in some cases, may be easily removed, or will even separate of its own accord. Hence it becomes our first concern to know how metallic surfaces may be rendered perfectly clean, the cleansing process being a preliminary operation to every case of deposition. All dirt and impurity in reference to this subject, may be arranged under two divisions,—first, greasy matters; second, metallic oxides; and the means used to remove impurities of these two kinds will remove almost all others.

For the removal of *grease*, chemistry at once points out the use of alkaline solutions. Soda, potash, or ammonia in any form will answer the purpose, and convenience will generally decide which should be adopted in any particular case. It is, however, commonly found advantageous to use the above alkalies in the form of common commercial "soda," of pearl-ash, dissolved in clean rain water, or of hartshorn. If the form of the article be such as admits of rubbing up with a stiff brush, it should be well brushed, with the addition of fine sand or emery-powder, immediately before placing it in the plating solution. In many cases, as with copies of coins, the dry method—that is, with brush and sand—is not only sufficient but the best that can be used; care being taken, of course, to see that the brushes are free from grease, and that neither hand nor fingers touch the object on the parts to be deposited upon.

For the removal of oxides, the brush and sand or emery should be used whenever the form of the object will admit of it. If the object have crevices or recesses which cannot be reached by a brush or other means of dry cleansing, it will be necessary to have recourse to an acidified solution. Sulphuric, nitric, or hydrochloric acid, diluted with water, will answer the purpose; but it will be necessary to observe that, if the solution be strongly acid—as, for instance, half acid and half water—the object must not be immersed for more than a second or two without examination; if the solution be weak, it may remain a minute or more. When it is sufficiently apparent that the surface is cleansed from oxidised matters, it should be washed in several waters successively; a weak alkaline wash may then be applied for the removal of all traces of acid, and, finally, one or two more water-washings for the removal of any possible impurities that may yet remain.

In practice, it will be convenient in most cases to use both the above methods, or a modification of either, as the judgment

and experience of the operator may dictate. It is especially useful when cleansing by means of sand and brush, to mix a little pulverized chalk with the sand, and to moisten it with hydrochloric acid; but a final scrubbing with the clean brush would in that case be necessary.

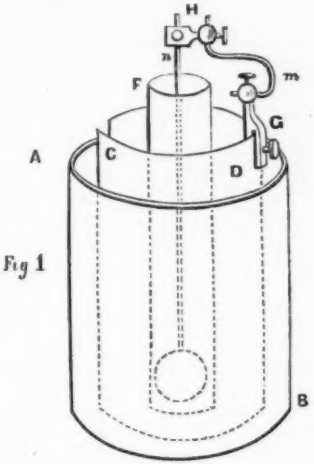

Fig 1

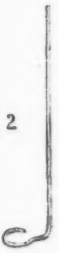

Fig 2

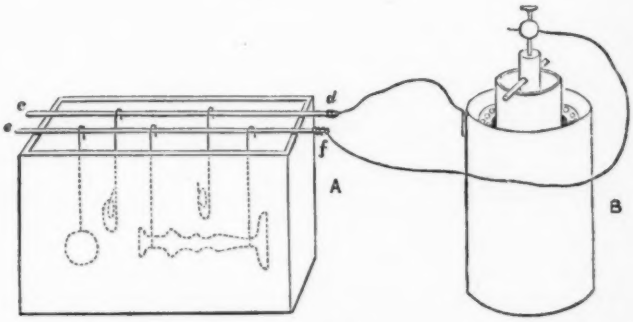

Fig 3

After the final cleansing, the object should be *instantly* immersed in the plating solution, and the manner of preparing this next claims our attention.

Several such solutions have been recommended by different chemists; of these, there is one more in favour than any other, and this alone I shall at present describe. It is that which I have used in making a great number of experiments, and is

easily prepared:—Dissolve in half a pint of clear rain water (or distilled water) one ounce of cyanide of potassium, if any sediment subsides, decant the clear liquor and add one-eighth of an ounce avoirdupois of oxide of silver; when the oxide is completely dissolved the liquid is ready for use. A gilding solution is made precisely in the same manner, merely substituting oxide of gold for oxide of silver.*

Supposing our solutions thus prepared, we may now arrange our battery apparatus, which, it will be seen, is of an extremely simple nature. Let A B be an ordinary preserve jar. Turn a piece of common sheet zinc into the form shown at C D, and attach to its upper edge the binding-screw G. Within the cylinder of zinc, place a porous jar, sufficiently large to receive the articles to be plated; and over this place a binding-screw, supported by the wire *m*. To the lower end of the wire *n* attach the article to be plated, and fix the upper end in the binding-screw H. In attaching the object to the wire *n*, convenience is the chief thing to be studied. I have obtained a perfect coating to objects by soldering them to the wire, by twisting the wire round them, or by binding the wire as in fig. 2, and laying the coin upon it. In either case the conduction is sufficiently complete to answer every purpose.

To set the apparatus in action, pour into the jar A B water acidulated with sulphuric acid (1 acid to 30 water), and into the porous vessel F as much of plating solution as will completely cover the object. The apparatus may then be left to itself, and in half an hour, or even less, the article will be covered with silver—very thin, as may be supposed, but perfectly covered, if all has been well managed. Thin as it is, however, it will be sufficient for articles intended for the cabinet, as copies of coins and medallions, or, indeed, any other object not subject to wear and tear. For works of art exposed to the atmosphere and dust, and which will, therefore, want occasional cleaning, a thicker deposit will be required, and two hours would probably be none too much for them; while in the case of spoons or forks, four hours would be necessary.

Were the experimenter not previously apprised of what he ought to expect, he would doubtless feel some astonishment on removing his medallion from the plating solution for the first time. Instead of a bright, sparkling, silvery surface, he would find a dirty-white, chalky-looking object, altogether unlike what he is aiming after; and though he might wash and wash again in water, the most he would accomplish by these means would be to render the surface of the object a little cleaner, though it

* It is well to know that these oxides when sold by chemists who supply practical platers and gilders, are obtained fully 25 per cent. cheaper than by those who sell them merely for experimental purposes; a fact that may guide the tyro in the choice of a shop.

remained as dull and chalky as ever. The deposit, in fact, is what is technically called "dead," as distinguished from "polished." He will, however, be glad to learn that this dull surface only requires the application of the plate-brush or a lock of cotton wool with rouge, to make it perfectly bright, that is, if the surface of the metal before putting it in the solution was bright; or if the form of the object admits of it, he may apply the steel burnisher, or a piece of polished agate, to bring up the surface to the requisite degree of brilliancy.

It is not, however, a matter of necessity that the deposit should be of this dead character. When the surface of the object operated upon is smooth and bright, a few drops of *bisulphide of carbon* added to the plating solution will cause the deposit also to be smooth and bright. Hence, it is worth while to learn the art of using this liquid judiciously, as it saves a great deal of subsequent labour, when polished surfaces are required in every part. But in the case of jewellery and many ornaments, a dead surface is preferred to a great extent, and only certain portions are wanted to be "brought out." In these instances, the "dead" deposit is obtained, and the burnisher does the rest.

Thus far we have spoken only of the single-cell apparatus, which is very certain in its operation, and easily constructed. By using porous jars of different sizes and shapes, its use may be greatly extended, and articles of various forms may be successfully treated by its means. But when the experimenter comes to deal with objects too large, or otherwise unsuitable to this form of apparatus, he will have to adopt the combination represented in fig. 3, which consists of a battery, B, and depositing trough A. The trough may be made of glass or porcelain, and should be furnished with two wires, *c d* and *e f*, long enough to rest upon the edges of the trough. These two wires are to be connected, one with the negative, the other with the positive plate of the battery. The wire *e f*, on which the articles to be plated must be suspended, is connected with the zinc (or negative) plate; the wire *c d*, with the copper (or positive) plate. Small hooked wires descend from these; those on *cd* being of silver, to keep up the strength of the solution, by replacing the metal deposited on the object; those on *ef* may be of copper, and are used simply to suspend the articles operated upon.

For objects of medium size, one cell of Daniell's or Smee's battery will be sufficient, and for larger ones two. In gilding a rather higher battery power will be requisite, and gold wire or gold leaf should then be suspended on *c d*.

On reviewing the operations above-described, and noting their simplicity, one cannot help feeling what resources they add to the means at the disposal of that numerous class of persons who cultivate "Homes of Taste." By means of apparatus

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costing but a few shillings, a man of moderate means may surround himself with articles of elegance and beauty, or supply for the use of his family articles of a more serviceable nature. Spoons, forks, fruit-knives, candlesticks, medallions, casts, salvers, anything, in fact, which may be purchased in brass or white metal, and of the form desired, may be coated with silver or gold at a small additional expense, while its value, whether for use or ornament, would be immensely enhanced.

There is another way in which this process serves a most useful purpose, and, in pointing it out, I am enabled to answer a question frequently put to me: "Is it possible to plate *a portion only* of a spoon, or fork, or other article, without plating the whole?" Now, nothing can be easier. Suppose—as the case was put to me a few days ago—suppose it is desired to plate the bowl of a spoon which has been abraded and worn, while the handle has been left unimpaired, a case often occurring to those who use electro-plated goods. Take the apparatus (fig. 1), and fix the handle of the spoon in the binding-screw (H); then adjust the wire so as to depress the spoon till the bowl is covered by the solution, and leave it as long as may be deemed necessary. Of course it is essential to the success of the experiment that the bowl be thoroughly cleaned and polished before placing it in the solution.

It is probable that it is this last application of the art that will recommend it most strongly to amateurs. Electro-plated goods are accessible to persons of narrow incomes; but they are commonly avoided, because it is known that they cannot be used long without being disfigured by abrasions in parts exposed to the wear and tear of daily use. When it is generally known, and practically demonstrated, that these parts may be easily and cheaply renovated, the chief objection to this kind of ware will be removed, and another step will have been gained towards the diffusion of works of beauty among the masses, who have hitherto been excluded from the enjoyment of them.

Thus far we have spoken of the deposition of gold and silver upon metallic surfaces alone; and the extreme simplicity of the process, together with the facility with which it may be performed, will recommend it to those who have had but little experience in the art. It happens very frequently, however, that the experimenter wishes to cover other surfaces besides these with a coating of the precious metals, and then some new difficulties present themselves which must next be pointed out and overcome.

Of the various substances used in the formation of models and casts, the most common are plaster of Paris, wax, gutta-percha, and sulphur. Now, none of these are conductors of electricity, and there is, perhaps, no operation conducted by the electrotypist which taxes his skill and patience more than that

of rendering the surfaces of his cast perfectly conductuous, and establishing an uninterrupted connection between the guiding wires and the surface to be deposited on. Spite of every precaution, and the most careful observance of prescribed rules, he is almost sure, in his early attempts, to have the mortification of seeing the silver deposited in abundance and perfection upon so much of the guiding wire as may dip below the surface of the plating solution, while his cast or model is as free from the smallest particle of the precious metal as it was before immersion.

Plaster of Paris (a material more commonly used, probably, than any of the above-named) requires preliminary treatment before applying the substance (blacklead) which is to make it more conductuous; for, if the blacklead be added to the bare plaster, it separates and peels off in flakes almost immediately after putting the cast into the solution. Various modes of preparation have been devised, but there is one which I have found very generally applicable, and which will most likely serve in a great majority of instances that come under the operator's observation. It consists in saturating the plaster-cast with a mixture of oil and wax. Take equal weights of beeswax and sweet oil, warm them sufficiently to reduce the former to a liquid state, and then place the plaster-cast in the mixture, moving it about so that every part of its surface may absorb a considerable quantity; when cold, the plaster will be found to possess a firm, tenacious, and somewhat adhesive exterior, admirably adapted for the reception of the substance next to be applied.

The cheapest and most easily accessible substance for rendering surfaces conductuous is plumbago, or blacklead, names which would suggest the idea that lead entered into its composition, whereas, when pure, they are quite free from that metal. Its correct name is carbide of iron,* and consists of carbon and iron. Neither the name or composition of the substance, however, is of any great consequence in so far as its present use is concerned, for we have to do with its conducting power, and not with its chemical properties. In applying it to plaster casts, a soft brush is the best implement to use, and with this it may generally be applied dry, especially if the cast be slightly warmed, so as to render the wax with which it is saturated a little adhesive; in other cases, breathing upon the object will do equally well: but a few hours' experience will aid the operator much more than whole pages of written instruction. When sealing-wax models require coating, they should be moistened with spirit of wine with the same view. Gutta-percha moulds take the plumbago readily without any

* According to some chemists; but later researches go to prove that the oxides of iron and manganese are in a state of mere mechanical admixture with the carbon, and form no definite chemical compound with it.

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preparation, and a brush as stiff as a tooth-brush may be used upon them without injuring the impression.

Supposing the surfaces of the mould to have been properly prepared, another point of at least equal importance is the attachment to them of conducting-wires, by means of which the mould may be connected with the battery apparatus. Little instruction is here needed: the electric fluid passes along the metallic wire readily enough, and when once it reaches a well-prepared conducting surface, its diffusion over every part of it may be relied on. The main point, therefore, is the perfect union of the two. In wax, sulphur, or gutta percha, the wires are easily fixed by heating their ends, and then pressing them into suitable parts of the mould. To fix them into plaster of Paris, small holes must be bored in the cast, and the wires fixed into these with wax or cement. Then, to render the metallic connection perfect, blacklead is rubbed on to the joint freely, and finally brushed up to the well-known polish.

Another mode of rendering surfaces conductuous is often resorted to, and, though a little more tedious at first, is on the whole more effective. A piece of phosphorus is dissolved in about twenty times its weight of bisulphide of carbon; in another vessel a solution of nitrate of silver is prepared. It need not be saturated; or, if a saturated solution is prepared, it may be diluted with about two or three times its bulk of water. The cast is immersed for a minute or two, first in the phosphorus solution, and immediately on its removal from this is placed in the solution of nitrate of silver. The action of the phosphorus on the silver salt is so energetic that, in a few moments after it has been removed, and left to dry *under the action of daylight*, the metallic silver is separated from its combination, and forms an exceedingly thin metallic surface to the cast. The inexperienced operator must not be deceived by appearances here, for he *will be* deceived if he looks for silver in the form in which it commonly presents itself to his notice. Silver, when deposited from its solutions by this method, is *black*, and an unbroken black surface is the best evidence he can have that his experiment has succeeded.

Nor must a deposit on a surface prepared as above be expected so promptly as on surfaces purely metallic. A deposit often appears in the neighbourhood of the conducting-wire in the course of an hour or so after immersion, but even then it will sometimes take several hours to complete the coating over every part of the cast. When once the coating is complete, however thin it may be, the further deposition of course proceeds rapidly.

As to the battery apparatus to be used in these latter experiments, it will suffice to state that the forms described for medallions and coins will answer equally well for these.

PARASITES FROM THE ZOOLOGICAL GARDENS.

BY T. SPENCER COBBOLD, M.D., F.L.S.,

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HAVING during the four successive winters of 1857—60, inclusive, examined the carcasses of upwards of one hundred different species of *vertebrata* dying at the Zoological Society's Menagerie, Regent's Park, we are enabled to form a tolerably accurate estimate of the prevalence of entozoa in animals subjected to a condition of domesticity as compared with those living in a wild state. It is, we believe, very commonly supposed that tame quadrupeds and other beasts kept "cribbed, cabined, and confined," are much more troubled with parasites than those fortunate individuals who roam at large "o'er hill and dale" without any human being to molest them. This conclusion, in so far as *external* parasites are concerned, may possibly be true (which, by the way, however, we very much doubt), but, as regards the frequency of *internal* parasites, we have satisfied ourselves as to the erroneousness of the general belief. About one-third only of the birds, reptiles, and quadrupeds just enumerated were found infested, or thirty-eight species in all; and of these, nineteen were mammals, fourteen were birds, and five were reptiles. This is decidedly a small proportion, and the comparative scarcity of the parasites is especially marked when we limit the question of their number with particular reference to the presence or absence of the members of that remarkable group of entozoa which we call flukes. In all our carefully conducted examinations we have only found seven different kinds of flukes, or trematodes, as they are more scientifically called; and as some of these offer interesting types of structure, and at the same time give rise to curious suggestions, it accords with our present purpose to offer a more or less brief account of each of them, omitting such details as are interesting merely to systematists. It may be premised, however, that a true explanation of the cause of this comparative freedom from flukes, which the animals in the Society's menagerie appear to enjoy, arises out of the circumstance that the *larvæ* of Trematodes exist only in a limited number and kind of molluscan *hosts*, and consequently quadrupeds, and other vertebrates from foreign lands, are not so liable to swallow the *larvæ* suitable to themselves, seeing that the larvæ frequently exist in molluscs, and in other *hosts*, which are not to be found in this country. No doubt, as in the case of the *Fasciola hepatica*, some trematode parasites will take

up their abode in a variety of animals; but, as a rule, applicable to adult as well as to immature forms, each fluke has a special liking for a particular *host*, though this "natural selection" is not always bounded by the consideration of the species, the genus, the family, or even, in some few cases, the order.

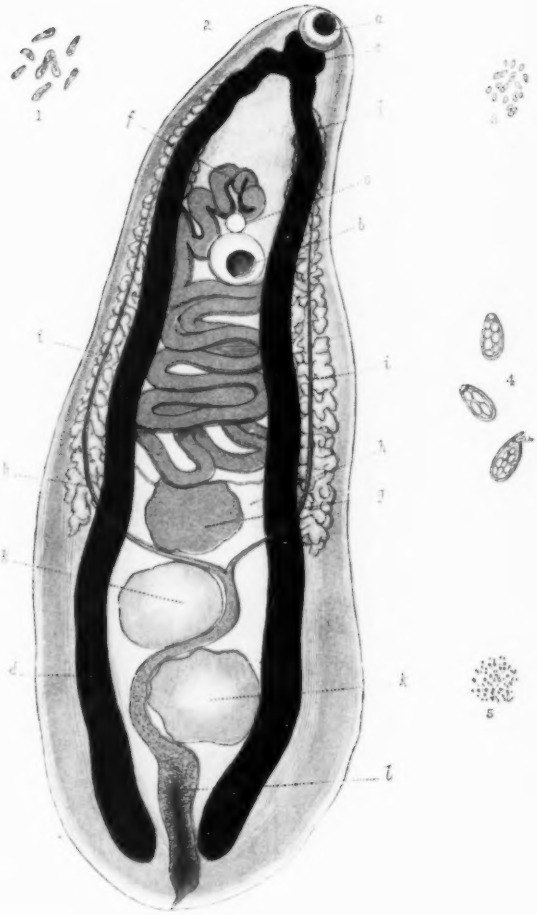
Without further prelude, we proceed to notice the seven flukes above referred to, in the following succession:—(1.) the *Distoma æquale* (Dujardin), from the alimentary canal of an American barn owl (*Strix perlata*); (2.) the *Distoma minutum* (T.S.C), from the duodenum of an oyster-catcher (*Hæmatopus ostralegus*); (3.) the *Distoma Boscii* (T.S.C.), from the lungs of an American snake (*Coluber*); (4.) the *Distoma coronarium* (T.S.C.), from the intestine of an alligator (*Alligator Mississippiensis*); (5.) the *Distoma conjunctum* (T.S.C.), from the liver ducts of the American red fox (*Canis fulvus*); (6.) the *Distoma compactum* (T.S.C.), from the lungs of an Indian ichneumon (*Viverra mungos*); (7.) the *Bilharzia magna* (T.S.C.), from the blood of the portal vein of the sooty monkey (*Cercopithecus fuliginosus*).

1. *Distoma æquale.*—On the 8th of January, 1858, nine examples were removed from the American owl. These little parasites scarcely exceed a line in length, but they exhibit a reddish-brown colour, in consquence of the numerous highly-coloured and extremely minute eggs which are seen through the transparent skin.

2. *Distoma minutum.*—This species is principally remarkable for its excessive minuteness, being barely discernible by the naked eye, and seldom exceeding the 1-100th of an inch in longitudinal diameter. Its form is entirely different from the *Distoma brevicolle* (Creplin), also described as infesting this bird, and in our early examinations we believe ourselves to have obtained satisfactory evidences of its sexual maturity. As, however, in so tiny a parasite, the appearances of true reproductive organs and ova may have misled us, we suspend further details regarding it until we have again had an opportunity of examining fresh specimens. Those we originally discovered were procured on the 19th of February, 1857.

Distoma minutum.

3. *Distoma Boscii.*—Though, like Bosc, we found a great number of these Trematodes occupying the cavity of the mouth, the larynx, and the lungs of an American coluber, yet we were not able to determine the precise *species* of snake from which our parasites were taken. There is no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doubt, however, of the identity of our fluke with his *Fasciola colubri*. This trematode is much elongated in form, flat, covered with little spines, and about one-third of an inch in length, on the average. It is furnished with a well-marked œsophageal bulb, two simple digestive tubes, and largely developed reproductive organs. Our specimens were obtained on the 20th of February, 1857.

Distoma Boscii.

4. *Distoma coronarium.*—This species is rather a prettily marked one, owing to the presence of a well-defined coronet of twenty-four spines which encircle the so-called head and mouth. On the 25th of December, 1860, we took large numbers from the alimentary canal of an alligator. The general aspect and character of this species is admirably represented in the accompanying wood-cut, which is copied from an original drawing made with the aid of a camera. This species has an average length of about one-fourth of an inch, but it is only about 1-30th of an inch in breadth. The body is linear, flattened, subconical in front, and somewhat attenuated posteriorly. The ventral sucker is less than one-half of the size of the oral opening, including the muscular cup. The body generally is smooth; the spines of the mouth being conical, pointed, and circumferentially disposed at the margin of the prominent lip. They form pretty microscopic preparations when preserved in glycerine.

Distoma coronarium.

5. *Distoma conjunctum.*—On the 24th of December, 1858, a considerable number of small flukes were obtained from the liver of an American fox, and as the species in question forms an admirable type of the genus Distoma, we have not hesitated to give an enlarged representation of it in the accompanying plate. In group (Fig. 1) eight individuals are represented of the natural size, and the accidental circumstance of finding two of them united by their suckers suggested the specific name above indicated. We have seldom seen a Distome in which the visceral arrangements were so simple, distinct, and compact as in this; and therefore to facilitate the investigations of those who are desirous of commencing a study of the organization of these curious parasites, we invite attention to the character and disposition of its internal organs. In Fig. 2 we have a view of the ventral surface of one of the individuals magnified thirty-five diameters linear.

At the upper or anterior extremity of the body we notice the round oral sucker (*a*), which is almost as large as the ventral sucker, or *acetabulum* (marked *b*). The mouth, properly so called, is placed at the bottom of the oral sucker, and leads into a small oval muscular cavity, which is termed the œsophageal bulb (*c*), and this, again, directly communicates with the two long, cylindrical, digestive tubes (*d*, *d*), which widen out a little as they approach the caudal extremity of the body, where they terminate in closed, rounded, cæcal ends. This arrangement constitutes the simplest form of alimentary apparatus with which we are acquainted in the trematode parasites, and, associated with the disposition of the two suckers as here placed, it is eminently characteristic of the genus Distoma. Immediately above, and in contact with, the ventral acetabulum there will be observed a small, round papilla (*e*); this is invariably furnished with and usually exhibits two minute openings upon it, which are respectively the orifices of the male and female reproductive organs. One of these openings communicates with that set of wide, tortuous tubes (*f*), occupying the centre of the upper half of the body. The brown colour is a natural appearance due to the presence of multitudes of mature eggs (Fig. 3) which are crowded within this coiled uterine duct, the latter being also connected by a narrow channel with the ovary (*g*), and by two other minute ducts, passing, one on either side, to the so-called yelk-forming glands. These last-named organs form botryoidal masses on either side of the body, and, though varying considerably both in extent and arrangement, their presence is in a measure characteristic of this class of parasites. The letters *h h* refer to these organs, but the dotted lines have been prolonged by the engraver rather too far inwards; the glands are coloured yellow. In Fig. 4 the lid-like end of one of the highly magnified eggs has been represented artificially burst open. The ova have a long diameter of 1-750th of an inch. The male reproductive orifice, like the other, is not seen in the accompanying illustration, but it communicates with the reproductive glands (*k*, *k*) by the intervention of *vasa deferentia*, or channels of outlet, in the usual manner. The true excretory system of vessels is well marked in this fluke, and consists of two main trunks (*i*, *i*) lying immediately in front of the yelk-forming glands; gradually increasing in size, and passing in a nearly straight line downwards, they converge to meet at a point corresponding with the centre of an imaginary line separating the lower third of the body, and in this situation the common tube sweeps round and between the reproductive glands in the form of the letter *s*, after which it swells out into a contractile vesicle (*l*), which opens externally by a very narrow outlet at

the centre of the so-called tail. The cavity of the vesicle contains a mulitude of highly refractive, glittering particles (Fig. 5) which, on their escape from the organ in a fresh state, display those curious and well-known phenomena of molecular motion in the greatest perfection. Finally, it is worthy of remark, that the flukes in question were found not merely here and there in single numbers, but in certain places they had accumulated to the extent of ten or a dozen, causing great swelling and cystic enlargement of the liver ducts, sufficient to have proved highly injurious, if not altogether fatal, to the animal they infested. A similar morbid change takes place in cattle where the *rot* has far advanced, and we have observed the same diseased conditions in a porpoise infested by another small species of the genus under consideration.

6. *Distoma compactum.*—Although flukes are most commonly found in the alimentary canal, and in structures associated with it, yet they are by no means unfrequent in the lungs, as our own investigations have proved. On the 19th of February, 1857, we obtained five examples from the left lung of an Indian ichneumon, which had been living in the Society's Menagerie for about a twelvemonth. They were lodged in cavities resulting from the inflammation their presence had excited, and thus, no doubt, contributed to the animal's death. This species is well marked, and easily recognised by the peculiar twisted condition of its digestive tubes, an arrangement very uncommon, and approaching the still more remarkable zigzag form of the same canals, which we found to occur in the fluke of the porpoise above alluded to. Another distinguishing feature in this species consists in the extended development of the yelk-forming organs or vitelline glands which almost entirely cover the lateral and dorsal surfaces; the reproductive papilla is here situated beneath the ventral acetabulum, and in the central line, a little below the papilla, the common duct of the vitelline gland on one side, is seen passing inwards to join its fellow of the opposite side before they enter together by a single trunk into the short and regularly folded uterine tube. A species of fluke, apparently distinct, but not unlike this, was long ago discovered by Natterer, at Matogrosso, Brazil, in cavities of the lungs of the American otter. Under the title of *Distomum rude,* Diesing has described and figured it in his *Neunzehn Arten von Trematoden,* published in the Transactions of the Vienna Academy of Sciences for the year 1856.

Distoma compactum.

Bilharzia magna.—This combined generic and specific name

is applicable to a somewhat remarkable entozoon which we found on the 4th of December, 1857, in the portal blood of the sooty monkey. It is particularly interesting from the circumstance that it is the second species only of a peculiar and recently established genus of flukes, the original type of which was discovered by that indefatigable naturalist, Dr. Bilharz of Cairo. Up to the time of Bilharz's announcement of the existence of the *Distoma hæmatobium*, so abundantly found by him in the people of Egypt, almost all the flukes were considered to be hermaphroditic, or, in other words, each individual was provided both with male and female organs; the only exception being that of the *Distoma filicolle*, regarded by Rudolphi and Dujardin as a species of Monostoma. So common and numerous is the *Distoma hæmatobium* in Egypt, that in 363 examinations of the human body after death Griesinger found this entozoon present no less than 117 times, and it is quite certain that it gives rise to a very formidable disease. In consequence of the reproductive peculiarity just mentioned, associated as it is with the existence of a remarkable ventral groove in the male, the writer, a short while ago, formed a distinct genus for the reception of the Egyptian fluke, substituting the name of the original discoverer of the species for the generic title of Distoma. Since this was done he has observed that several foreign parasitologists have been led to act in a similar manner, and, as usually happens in such cases, they have adopted different generic titles, so that we are in danger of complicating the nomenclature, and exposing ourselves to the ready criticism of those who love simplicity. Thus Professor Leuckart of Giessen, says we must yield priority to Diesing of Vienna, who, in 1858, proposed the generic term Gynæcophorus, in reference to the so-called gynæcophoric canal of the male above-mentioned. Dr. Weinland of Frankfort subsequently formed his genus Schistosoma for similar reasons. Without, however, further dwelling on this question as to its proper name, we shall here employ the one first proposed by ourselves, directing special attention to the fact that the genus, in itself so peculiar, is only yet known to infest men and monkeys, and in these *hosts* the two species appear to be confined to Egyptians and the sooty monkey. Here is an interesting little circumstance, admirably suited to

Bilharzia magna (upper two-thirds).

the taste of those who are on the look-out for affinities of habit between bimana and quadrumana. The *Cercopithecus fuliginosus* is an African monkey, and no doubt in its native haunts it procures the larvæ of *Bilharzia magna* from the same, or from similar sources as those from whence our brethren in Egypt procure the larvæ of *Bilharzia* (Distoma) *hæmatobium*. Animals lower in the scale do not appear to be liable to attacks from this strangely organized genus of flukes, and as yet we are uninformed as to the *hosts* which entertain it in its larval condition. The adult fluke from man never exceeds one-third of an inch, but the solitary example which we obtained from the monkey was about an inch in length. Griesinger conjectures that the young of Bilharzia exist in the waters of the Nile, in the fishes which therein abound, or even in bread, grain, and fruit; but, in our opinion, it is more probable that the larvæ, in the form of cercariæ, rediæ, and sporocysts, will be found in certain gasteropod molluscs proper to the localities from whence the adult forms have been obtained. Our sooty *host* was, we understood, imported direct from its native country, and was not bred in the Society's gardens; had it been otherwise he would not, in all probability, have been infested by *Bilharzia magna*.

THE ANGLER.

BY JONATHAN COUCH, F.L.S., ETC.

This fish has been called the toadfish, frogfish, fishing frog-monk, and sea-devil. It is the rana piscatrix and rana marina of old writers, and lophius piscatrix of Linnæus and Cuvier. It appears also to be the fish which is described by Caius at the end of the work *De Canibus Britannicis*, under the name of ceruchus; but he does not seem to be aware that it had been noticed by any other writer; and indeed he may have been, as he remarks, the first who gave a precise description of it.

But the remarkable form of this fish in connection with its still more remarkable manners, had attracted the attention of observers of Nature from the earliest times; and, strange to say, at a time when imagination, superstition, and imposture were united in ascribing to the inhabitants of the ocean mysterious properties—so that the circumstance of his inquiring into their nature and structure was believed to be a sufficient proof to show that Apuleius, the Roman writer of the famous romance the *Golden Ass*, could be no other than a magician—and, when

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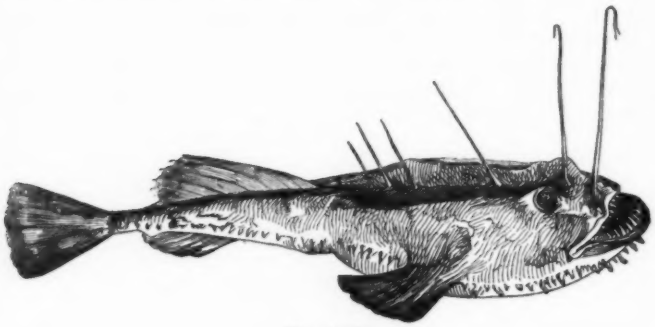
in numerous particulars of form this fish differs much from all others that were known to the ancients, there was, still, considerably less of the wildness of imagination applied to it than to a large proportion of the others. The general appearance of this fish, which is represented as at least unsightly, has caused it to be compared to a tadpole, but a tadpole of enormous size; and when the rough protuberances of its head, and its projecting teeth and ample mouth were taken into the account, its supposed hideous aspect was judged sufficient to entitle it to the designation of sea-devil. Yet, in the form and arrangement of these parts, we can discern a noble example of exquisite contrivance.

The teeth of this fish are set round the mouth like the prongs of a rat-trap; and are long, strong, pointed, and those of the lower jaw are directed obliquely inward; so that as this jaw is withdrawn to close with the upper, these teeth may



The Angler.

become interlocked together, and thus prevent the escape of the prey; while the teeth of the tongue and gullet by the action of muscles which act on the latter, prevent such a struggle as might obstruct the process of swallowing. The teeth appear to be in a state of perpetual renewal, and those of the inner row are, for the most part, the largest. They carry with them, in their growth, a covering of the membrane from which they are produced, and from it, perhaps, they derive nourishment long after their protrusion from the gums, and it may be some amount of sensation. The instinctive force with which the angler retains its prey, when this has come within the grasp of its teeth, may be judged from a fact related by the natural historian Jonston, who tells us that the fish had been left on the beach by the receding tide when a fox came prowling along in search of provender, and chanced to thrust

its nose within the compass of the expanded jaws; which then closed upon it and held it fast, until after a considerable time, the captive was discovered by people that were passing by. Mr. Thompson of Belfast records an instance where a gentleman discovered an angler near the shore, and presented the butt-end of his whip to it, when it seized and held by it until it was thus drawn on shore. An angler of large size was also discovered in shallow water, by a couple of boys who were in a boat, where they happened to be without oars. But with the intention, perhaps, of annoying the fish, they loosened a board that lay along the bottom of the boat and thrust it within the creature's expanded jaws, which immediately closed upon it. A struggle then commenced; but so firmly did the fish retain its grasp, that it suffered itself to be dragged out of the water and secured.

It is by this, as in the corresponding instance of the apparently sluggish lumpfish, that what seems at first sight a defect is fully balanced by a skilful adaptation of instinct and inward organization, so as to answer to that definite end which comprises the comfort and safety of the creature itself. It was further the instinctive habits displayed by the angler, that especially drew the attentions of ancient philosophic observers; and, accordingly, we find them particularly described in the poet Oppian's verses; although, indeed, they are there accompanied with the addition of some particulars which tend to raise a doubt whether this usually accurate writer had closely studied the fish itself. He represents that—

> "Within her jaws the fleshy fibre lies,
> Whose whiteness, grateful scent, and worm-like size,
> Attract the shoals and charm their longing eyes.
> But as they near approach with subtle art,
> The wily toad contracts the inviting part."

A more accurate description of the organ and its use is given by Ælian, b. 9, c. 24, where he says the fishing frog derives its name from the manner in which it employs itself. In front of its eyes there are placed some long processes, to the end of which are affixed enticing baits for the purpose of enabling it to ensnare little fishes. This toadfish is aware of the use it may make of these organs to obtain food, and for concealment hides itself in some muddy place, where it keeps its body unmoved while it lifts up and stretches out its line and bait. Little fishes that are wandering about are soon attracted, and begin to nibble, which the angler is quick to perceive, and then it proceeds to move its line in a cautious manner, so as to lead the prey, without alarming them, in the gulf of its jaws, which then close upon them beyond the power of escape.

The generally abrupt depth of water in our seas is a hin-

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drance to the observation of such actions as these, but there does not appear to be any reason for doubting the accuracy of this account; and on the contrary, an examination of other portions of the structure of this fish will tend to point out an extension of these powers in other directions. Thus, from the jaws round the border of the body to the tail there is found a row of membranous or cutaneous lobes, which in most instances, at their extremities, are divided into club-shaped partitions. These are not merely insensible doublings of the skin, but, although in a less degree, they perform the office commonly assigned to the fictitious bait suspended from the fishing-rod, on the top of the head. They offer themselves enticingly to be nibbled by fishes which wander in that direction, and then is brought into exercise an organization which distinguishes the structure of the pectoral and ventral fins. The species of this and the neighbouring family of blennies, possess the power to change their place as they lie on the ground without an effort of the tail or dorsal fins; which latter organs are the instruments of motion in the generality of fishes, but which if put into action by the angler would excite alarm, and so drive away the prey. The pectoral fin of this fish possesses such a frame-work of bones as is equivalent to the wrist-joint of a higher class of animals, and the ventral fin also is fitted with joints resting on a firm series of bones, to which also the pectoral is attached; and the whole is so well supplied with nerves of sensation that, with slow but sure and consciously directed motion, the fish is enabled to creep in advance or retreat, or to turn itself round, and so lay hold of such incautious rovers as have crowded round it without a suspicion of the danger proceeding from the gaping but quiescent cavern of a mouth. And formidable indeed is that gulf, which, as we have seen, lies open to receive the prey—as hungry is the stomach which is prepared to receive it.

But sometimes stratagem will fail to supply the cravings of a hungry stomach; and then, in spite of its inaptitude for effort, the angler will mount into the higher regions of the sea, and there, without discrimination, endeavour to glut itself with any object that may attract its attention. It has been known to grasp within its jaws the floating barrel which is usually fastened to the head of a sean, and it has swallowed the large white-washed ball of cork which formed the buoy of a crab-pot, by which it became choked. When an individual was seen by a fisherman to be swimming near the surface, he threw his boat's iron grapnel at the fish, but not terrified with the blow the fish turned and seized the object as it sunk. Again, a struggle was observed at the surface, and on the approach of a boat it was found to proceed from an angler in its efforts to swallow a gull

which it seems to have laid hold of as it was floating on the surface. The fish measured three feet in length, and had so far swallowed the bird, which was found to be the *Larus argentatus*, and which measured almost four feet six inches from wing to wing, as that its stomach and gullet were filled, while the feet, tail, and ends of the wings projected from the mouth. The fish had become choked with struggles of its prey, and they together form a portion of a local museum. An angler was seen to have seized a bird called the northern diver—*Colymbus Glacialis*—but after a long and earnest struggle both the combatants were secured by a fisherman. And, however difficult it may be to imagine how it can happen that such an apparently unwieldy fish has been able to lay hold of the active birds and fishes we have mentioned, some portion of the difficulty will disappear when we know, that in addition to the width of the gape and stealthiness of approach, by a particular construction of the uppermost portion of the chain of vertebræ, by which a distance is preserved between the upper processes of these bones close to the head, and the head itself, the head may be lifted without any motion of the body, which is contrary to what takes place in the generality of fishes.

As another proof that the angler sometimes seeks its prey at midwater, a fisherman had hooked a codfish, and while drawing it up he felt a heavier weight attach itself to his line; this proved to be an angler of large size, which he compelled to quit its hold as it grasped its prey across the mouth, by a heavy blow on the head, and the codfish still remained attached to the hook. In another instance, an angler seized a conger that had taken the hook, but after the last named fish had been engulfed within the cavern of the mouth, and perhaps the stomach, it struggled through the aperture of the gills, and in that situation both the fishes were drawn up together. This fish is all one vast extended mouth, says Oppian, to which we may add by adaptation from our English poet Spenser:—

> "The open mouth that seemed to contain
> A full good peck within the utmost brain;
> All set with dreadful teeth in ranges twain,
> That terrified his foes and armed him,
> Appearing like the mouth of orcus ghastly grim."

The extent of the mouth is indeed formidable, for in an example which measured four feet and a half in length, and weighed seventy-two pounds, this organ measured fourteen inches across; and this in action is capable of being greatly extended by means of several joints with which these parts are supplied to a larger degree than in most other fishes. In opening the mouth the lower jaw is rather protruded than lowered. The upper jaw also is capable of some degree of protrusion, and in its symphysis a

sidelong motion is also put in action, by which it appears possible that the angler may be able to swallow a prey equal or nearly so to its own bulk; to which also a wide gullet can afford a passage, and the stomach a welcome, while the skin of the body is so loose as to allow of any degree of distension without inconvenience, and there are no ribs on the sides that might offer a mechanical resistance. Nor can the food pass easily out of the stomach into the intestines without being entirely digested, for the lower or pyloric orifice of that organ is small, and there is reason for supposing that the process of digestion is itself slow. On one occasion there were found in the stomach of an angler nearly three-quarters of a hundred herrings; and so little had they suffered change that they were sold by the fisherman in the market without any suspicion in the buyer of the manner in which they had been obtained. In another instance there were taken from the stomach twenty-one flounders and a dory, all of them of sufficient size and sufficiently uninjured to make a good appearance in the market where they were sold.

And how indiscriminately fishes feed on each other appears from the fact, that in the stomach of an angler which measured two feet and a half, was found a codfish that measured two feet; and in the latter were the skeletons of two whitings; within which, again, were other small fishes.

As this fish has on some occasions displayed a considerable degree of apparently stupid indifference to fear, with remarkable want of caution in avoiding danger, it has been concluded that its powers of perception are in a low degree; and this opinion is strengthened by noticing the small size of the brain in comparison with the bulk of the body. It scarcely fills half the chamber of the skull in which it lies; the remainder of the space being occupied with water, as in other fishes; and it is even said that this brain is in bulk but little above that of a sparrow. The whole head also is regarded as being in a condition of restricted, or arrested development; for, as in most animals in their embryotic state, the head is proportionally larger in reference to the body than it continues to be in the condition of perfect development, it has been judged that its existence in the magnitude we find it in the angler is a proof of the small development also of its other powers. But the abstract truth cannot be reached by such an analogy, and it is to be questioned whether a comparison of the brain of this fish with that of the sparrow be in any respect a just one. There are in all creatures nerves and portions of the brain which are endued with special sensibility—as that of seeing, hearing, and tasting—but in which the anatomist, with his microscope, has not yet learnt to discern a different structure from that which

is possessed by other nerves that are altogether insensible to such, or any other conscious sensations.

And again, there exist creatures which, to all appearance, are guided by strong powers of reason in their animal actions, whose brains are vastly smaller in absolute size than that of the angler. The weight of the brain of the bulky fish and of the bird may therefore be the same; but we know that their form, extent of surface, and arrangement of parts, are different; and it is probable that the internal structure of the lobes is still more so—as we know further is the expansion and arrangement of the nerves of the external development of the organs of sensation—in which last particular, indeed, this fish excels a large number of the other inhabitants of the sea. The eyes are directed towards the sides, so that they cannot, as in the case of the skulpins and other flat-headed stargazing fishes, be brought to bear together on a single object; and such is the size of the crystalline lens that, with its strictly globular form, and its position on the posterior part of the chamber of the eye, close to the retina, or nerve of sight, objects at a moderate distance can scarcely be discerned; but it is here that the special function is displayed of a particular muscle of the interior of the eye, first described by Mr. Dalrymple, and known to exist in some other fishes. Its influence is to draw back, as that of the external director muscles is to press forward, the crystalline lens, that by modifying the angle at which the rays of light cross each other, and so enable the fish to discern more clearly at varying distances. There is reason to believe also, that the iris of the eye is furnished with muscular fibres, by which the quantity of light which passes inward to the nerve of sight may be regulated; and how necessary this must be to the varying habits of the fish will presently be seen. In common with some other kindred fishes, the angler is able to move its eyes in various directions, and it is probable that this is effected by each one independent of the other, as is certainly the case with the blennies. From the appearance of lines or stripes on the iris of the eye, there seems reason to suppose also that the organ is capable of contraction and expansion; by which means the eye may be fitted to the varying degrees of light as it exists near the bottom or at the surface of the sea. This fish is retentive of life, so that when the skin has been kept moist, it has been known to live out of its proper element several days.

It is known that the race of this fish is continued by means of spawn, as in other bony fishes; but much obscurity has existed in regard to the early stages of its growth; and from the observations of Dr. Günther, in the *Annals and Magazine of Natural History* for 1861, there appears to be a foundation for the supposition that in its young condition it possesses a

different shape from what it subsequently assumes; and that in this state it has been regarded even as a distinct species, under the name of lophius eurypterus; but a remarkable portion of the history of this species is the scarceness of this young condition as compared with the commonness of full-grown examples, and its prolific character. Mr. Thompson weighed the roe in an angler which measured four feet and a half in length, and found the bulk enclosed in the membrane to amount to one pound and thirteen ounces; from which, with due allowance for the superfluous materials, he concluded the number of grains to amount to almost a million and a half.

This fish is not thought of for table with us; but Jonston quotes an unknown author, Alexandrides, for the fact that it was produced at a feast given by Cotys, King of Thrace; and, according to Antiphonis, the belly was particularly esteemed. Willoughby says that when boiled the flesh is white, and in taste like a frog; to which we may add that, according to Risso, a fish which he calls genelli, and which he considers as a variety of the angler, is a delicious dish, as has also been reported by a private individual of our own angler.

A large example of this species may measure in length between five and six feet, but the specimen described measured three feet, and its breadth across the widest expansion of the pectoral fins, about twenty-two inches. The head broad and rounded, forming a large proportion of the bulk; the body tapering behind the pectoral fins, and more compressed towards the tail. Head studded with bony tubercles, six in number, with a depression from the symphysis of the upper jaw upward between the rows, in which the processes of the maxillary bone are received. The lower jaw projects, and is capable of great protrusion; breadth of the mouth in this example ten inches, with two or three rows of long, sharp teeth, the innermost row generally the stoutest and longest, especially in the lower jaw, and each tooth through much of its length encased in its own membranous covering; in front of the palate also are rows of strong teeth, and the same in the floor of the mouth in the place of tongue. Eyes high on the head separate, with a depression between them; vision towards the sides. Round the body from head to tail a series of membranous processes, flat and lobulated, but of some variety in shape; the longest round the head. Skin smooth, loose, and slimy. Strong tubercles behind the eyes; the head covered with numerous irregular lines, from which proceeds a tenacious slime. Two short soft processes, already referred to, above the upper jaw; between them a slender upright filament, its interior structure bony, and which is joined to the bony substance of the head in some cases by a ring joint; in others, a portion of the ring is formed of soft

substance. This forms the fishing-rod and line; its termination expanded, soft, hanging down like a bait, and in this example the whole was nine inches long. Behind this are five slender processes, obscurely united by a membrane, which may be regarded as the first dorsal fin; these processes or rays becoming gradually shorter, second dorsal and anal opposite each other, the former having twelve rays, the latter ten; pectoral fins horizontal, with twenty-four rays, joined to the body by a lengthened wrist which is hid under the skin; and the longitudinal direction of the bones of the wrist causes this fin to be placed far behind, yet not so far as the gill opening, which is situated behind it, and is so open in consequence of the loose nature of its membrane and the length of the six slender branchial bony rays, that by fishermen the pair are termed pockets. The ventral fins resemble slender paws, with six rays. Tail slightly rounded, with eight rays; all the fins thick and fleshy, with lobes or crenations at the border. The colour above is of various shades of dark or ashy-grey, mottled, and in a younger condition, prettily and regularly striped, white below: extremities of the fins often red. The olfactory portion of the brain exists as a separate globe of nervous matter, distinct from the united ganglions forming the true brain, although it is united to it by a bar or string of nerve; and from this anterior globe proceed some fine fibres which we should have described as passing foward to the perforated elevations above the upper jaw, which we suppose to form the nostrils; but we hesitate to say that these fibres are actually united to or expanded on these membranous processes, since Professor Owen, whose accuracy in observation no one will question, has not been able to trace them thither. These processes are also furnished, at their root at least, with nerves of considerable size, but which are only organs of feeling, as is the nervous trunk from which these branches spring, and which conveys its powers of sensation over the face and to the corners of the mouth with the neighbouring parts. As this nerve is the largest in the body, except the nerve of sight, we may believe it to bestow the function of exquisite touch in a degree proportionate to its superior size. There exists in this fish also what perhaps we should least expect to find in it, an organ of hearing, which it possesses in a higher degree of development than in many other species. It is true there is no external orifice by which undulations causing sound can obtain access; but there is no reason to suppose that any modulations of sound are felt by any true fish. It is only a few variations of noise or tone that are perceived by them, and in this particular the angler is at least equal with the generality of the inhabitants of the ocean. But to the eye of this fish we would direct particular attention, as it is in its structure we

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discern it to be better prepared for variety of vision than is the case with the larger part of bony fishes. The crystalline lens is large, by which means it is able to take in a wide range of vision, while its situation far back in the chamber, and very near the retina or expanded fibres of the nerve of sight, from which, by bringing the rays of light to a short focus, the distance at which objects would be seen must be small, is changed, and a larger extent of perception secured by the compressing operation of the external muscles of the eye-ball, the lens itself being thus driven forward towards the front.

THE PRINCIPLES OF SPECTRUM ANALYSIS.

BY THOMAS ROWNEY.

SIXTY years or more ago Dr. Wollaston detected in the spectrum obtained from solar light a series of dark bands crossing it throughout its entire length. These lines may be easily seen through a prismatic telescope, of which Mr. Crookes has contrived a simple form. The discoverer does not appear to have thought much of the fact, and seems to have discontinued his experiments, as we have no further account of his researches in that direction. It was not until Fraunhofer of Munich announced his independent discovery of the same lines, and showed that they were constant both in number and position, and mapped them out to the extent of more than 600, with the most sedulous care, that they came to be regarded as features worth notice. He showed that these lines, which now bear his name, might be found in all spectra, by viewing them through a telescope, whether the source of light were the sun, moon, fixed stars, or planets. He also found them in the electric spark, and in flames coloured by the combustion of metals. These two philosophers might justly lay claim to the honour of having laid the foundation of what is now termed spectrum chemistry. In the words of Dr. Miller,*

"The inquiry thus launched by Fraunhofer has been followed in four principal branches of research, which may be described as relating to,—

"1. *Cosmical lines*, or the black lines produced in the light of the sun, the planetary bodies, and the fixed stars.

"2. *Black lines produced by absorption*, a class of phenomena discovered by Sir D. Brewster, in his observations upon the red vapours of nitrous acid.

"3. *Bright lines produced by the electric spark*, when taken between different conductors.

* Lecture reported in *Chemical News*, No. 123.

"4. *Bright lines produced by coloured flames*, or by the introduction of different substances into flame.

"The following chronological table contains the names of those who have made the principal steps in these different subjects:—

"Newton.....1701
Wollaston.....1802
Fraunhofer 1815

Cosmical.

Brewster, 1832.
E. Becquerel, 1842.
Draper, 1842.
Stokes, 1852.
Brewster and Gladstone, 1860.

Absorption Bands.

Brewster, 1832.
W. H. Miller and Daniell, 1833.
W. A. Miller, 1845.

Electric Light.

Wheatstone, 1835.
Foucault, 1849.
Masson, 1851—55.
Angstrom, 1853.
Alter, 1854—55.
Secchi, 1855.
Plücker, 1858—59.
V. Willigen, 1859.

Coloured Flames.

Brewster, 1822.
Herschel, 1822.
Fox Talbot, 1826, 1833, 1834.
W. A. Miller, 1845.
Swan, 1857.

Kirchoff .....1859.
Kirchhoff and Bunsen.....1860."

In order to a right understanding of the results which have been reached by the recent labours of Kirchhoff and Bunsen, it is necessary to be acquainted with the nature of the dark lines, which are so many touchstones or tests by which they have worked them out. Let us suppose a prism of blue glass to be used for effecting the decomposition of a ray of solar light. We have an elongated image, not, however, containing seven colours, as when a white prism is used. The yellow, blue, and green are all absorbed, and we have only the two extreme colours, violet and red, the latter also diminished in breadth, A comparison with the normal spectrum will make the difference at once clear. In passing through our atmosphere, or the atmosphere of the sun, similar changes may take place, and thus materially assist in producing these dark lines. Moreover, there are a class of rays in the solar spectrum which our eyes cannot see, and of which we can only judge by their effects. Of such are the chemical rays which manifest their action in the beautiful results of the photographic art. We may instance also another set found beyond the violet rays, whose presence has been demonstrated by Professor Stokes, by transmitting them through a solution of sulphate of quinine. They have a light bluish-lavender colour. Thus, it will seem that certain

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rays have such a refrangibility that our eyes cannot take cognizance of them; and so also certain rays exist in solar light which are incapable of transmission through certain media. Applying this to the solar spectrum, we have a clue to the production of the dark lines, by supposing, with Kirchhoff and Bunsen, that the sun has the property of inducing or giving out rays of a certain refrangibility, but yet cannot produce others capable of filling the interspaces. Another interpretation has been given, by supposing an interference in the undulations of certain rays, which produce darkness; but this theory will not meet the circumstances of the case, and we can show by experiment that by making an artificial atmosphere the same or parallel results can be produced.

The natural variations in the composition of the atmosphere produce similar effects, and Brewster was the first to notice bands in the red and green spaces, whose appearance was not constant. These appearances are usually observed when the sun is not far from our horizon; and Dr. Miller mentions an instance in which he saw a group of lines during a thunder shower. They came suddenly, and faded as the rain passed away.

The readiness with which the spectrum responds to changes in the atmosphere, or in the nature of the source of light, is shown in the following experiment of Kirchhoff and Bunsen:—

They threw up into the air of the apartment a small quantity of chloride of sodium in very fine powder. Motion was imparted to the atmosphere, to ensure an equable diffusion of the salt. The spectrum in an instant demonstrated its presence, by showing a golden-yellow band in the yellow space. This effect is uniform whenever sodium is present in a state of incandescence, and is therefore called the sodium spectrum. This result might have been expected, knowing that sodium in any form always tinges flame an intense yellow; but when we come to the combustion of other metals, the bands produced by them are such as could never have been anticipated. When silver is burnt we have other coloured bands brought out equally characteristic, and so with every other metallic substance. To show the relation between these coloured bands and the dark lines, we will suppose the light of a pure white flame to be passed through a yellow sodium flame, and then through the prism. Now, mark the change. The spectrum is no longer continuous, and having its bright yellow band in the yellow space; but where it flashed out so conspicuously is now to be seen a dark line, known as "D." The rationale is obvious. The yellow atmosphere has interfered with the yellow of our normal spectrum, and by that interference darkness has resulted.

Keeping these results in view, we have a key to the whole subject of spectrum chemistry. It can be shown that each

metal in a state of vapour has the power to arrest particular rays with a constancy that can be relied on. The arrangement best suited for these experiments is either Dubosq's electric lamp, or the Drummond light, but many of the spectra may be conveniently studied by using Crookes's spectroscope, as made by Spencer Browning and Co., and now too well known to need detailed description. This instrument is well adapted for ordinary purposes, but to appreciate the full beauty and delicacy of the various spectra, we should need an apparatus as perfect as that constructed for Kirchhoff by Steinheil of Munich.

When artificial light is employed—as that of gas or lamp—the dark lines may be brought out by interposing a glass trough or bottle containing nitrous acid gas between the light and the instrument. This gas may be obtained by the action of a small quantity of nitric acid on a piece of copper; and, as we have before mentioned, it acts as an absorptive medium. If a piece of sulphur be introduced into the flame of a spirit-lamp, a good view of its dark bands may be obtained. If the subject for examination be an alkaline metal, the spirit-lamp may be used, or better still, a flame of hydrogen mixed with air and burnt on the top of a tube covered with wire gauze. We thus obtain a flame of high temperature with little light, except what is derived from the substance employed. The metal in a state of chloride is the most convenient form—it being more easily volatilized. It may be introduced into the cotton wick; or if the gas-burner be used, then a loop of platina wire sliding on an upright support is the easiest to manage. The copper spectrum may be readily obtained by dipping a coil of fine wire into pure hydrocloric acid, and immediately inserting it into the gas-flame. When iron, silver, etc., are operated upon, wires of these metals should form the electrodes of a powerful voltaic battery, and be brought by its agency to an incandescent state, when a portion of their substance is volatilized, and exhibits its characteristic action through the prism.

Kirchhoff and Bunsen, while pursuing their researches on the composition of some mineral water, obtained from the combustion of the solid matter a series of bands in two spectra, which did not correspond with those produced by any of the known metals. This led them to infer the presence of some new elements which the eye of man had never yet seen. After evaporating several tons of the fluid, their labours were rewarded by obtaining two new metals, which they named Cœsium—(greyish blue) that being the colour of the bands—and Rubidium (dark red). No sooner had they done this than they were off into the depths of speculation, conceiving that they had in their power a means of analysis capable of much higher application.

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These ingenious and indefatigable workers found that the bright lines in the metallic spectra corresponded closely with the dark lines of the solar spectrum. Why was this? and how could it be explained? They found, by experiments before cited, that each colour was opaque to rays of its own colour.

To illustrate the point more clearly, we may suppose two pendulums of equal length to be placed side by side. If the one be made to vibrate, it will, after a time, cause its companion to do the same in consequence of its equal length or isochronous condition; and so it is supposed that the rays of one colour will be taken up by another whose vibrations are of equal length, and so be arrested in their voyage. Now look at the application of this result. If, in the rays of light from an artificial source, this principle be correct, it may also be correct with the rays of solar light. Hence they have inferred that the dark bands of the solar spectra are produced by their passage through an atmosphere containing certain metals in a state of high combustion or vapour.

Upon these grounds they have concluded that in the outermost solar envelope exist all those metals in a state of vapour, whose colour-bands coincide with dark lines of the solar spectrum, as sodium, potassium, iron and nickel; and that it is by the more powerful light of the photosphere shining through this only feebly-luminous layer that the dark bands of Fraunhofer are produced by the process before described. They have also inferred the source from which these metals are derived to be the mass of the sun. A bold assertion, perhaps a correct one; but we are certainly not at present justified in accepting it as if it were proved; and we may advantageously reflect upon the words of Dr. Miller:—

"Fascinating as this theory is, it must be remembered that it is yet upon its trial, and that it does not explain the facts at present known respecting the vapours of hydrogen, mercury, chlorine, bromine, iodine, and nitrogen. M. Morren even questions the accuracy of some of Kirchhoff's observations. Thus, he states that in a measurement which he made of the red band of potassium, conjointly with Plücker, they found that it did not correspond with the solar line A, but that it is considerably more refrangible."

There are many other important facts which will have to be considered before we can arrive at a complete theory of the spectral phenomenon. For example, chloride of lithium produces a single crimson line in the flame of a Bunsen burner; the greater heat of a hydrogen flame enables it to emit an orange ray, and the voltaic arc adds a brilliant stripe of blue. In like manner, iron and other metals furnish spectra which advance in complication as the temperature of their vapour is increased.

Professor Roscoe says that "the general rule is that *lumi-*

nous solids give off a different *quality of light* when they are differently heated, and luminous gases give off the same kind of light at all temperatures."* The spectra of gases are quite as interesting as those of the metals; hydrogen, for example, giving a red and a blue band, and nitrogen beautiful violet stripes.

THE FEATHERED REPTILE OF SOLENHOFEN.†

Last summer M. Witte of Hanover, called the attention of M. A. Wagner to a slab of the well known Solenhofen lithographic slate, about one and a quarter square feet in size, containing fossil remains of an extraordinary and bewildering character. The skull, neck, and both hands were wanting, but the greater part of the dorsal vertebræ and all belonging to the tail were well preserved. The humerus and fore arm, consisting of radius and ulna were present on both sides. "At the anterior extremity of each fore arm there is a broad short bone which is injured." The pelvis, more like that of a Pterodactyl than a bird, is imperfect, the right side only remaining. The hinder extremity is complete on the left side; on the right only the thigh and shank remain. The thigh bone is strong but not long, and the shank not perceptibly divided into tibia and fibula. The tarsus consists of a single powerful bone shorter than the shank, and having its lower extremity widened, and bearing three articular processes to which as many toes are attached. The latter are of moderate length, and armed with strong hooked claws. Except to the comparative anatomist, these singular remains might present nothing striking, but the description proceeds to tell us that the anterior limbs and tail were covered with feathers, which have left their impressions in well marked lines. "From the short broad bone which lies close to the extremity of each fore arm there issues a radiating fan of feathers, by which two feathered wings are produced, having their external outline curved like a bow." The tail is also feathered, but the feathers are shorter than those of the wings, and instead of radiating from the end of the tail they spring from both sides throughout its length, starting at a small angle, and forming a "leaf like or oval group." Before the discovery of this fossil, Von Meyer described a feather from the same quarries, which he conjectured to have belonged to a bird, as it was not to be distinguished by any special peculiarity. On receiving the account of M. Witte's investigation, he however came to the conclusion that the feather he had seen must

* Lecture at Royal Institution reprinted in *Chemical News*.

† See *Annals of Natural History*, April and May 1862.

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have belonged to a "similar animal," which he designated *Archæopteryx lithographica*. For various reasons drawn from comparative anatomy, M. Wagner rejects the idea of the creature having been a variety or new kind of bird. He says "a reptile with the simple tarsal bone of a bird, and with epidermic structures presenting a deceptive appearance to bird's feathers, is far more comprehensible to me than a bird with the pelvis and vertebral column (especially the long slender series of caudal vertebræ) of a long tailed Pterodactyl, and with a perfectly different mode of attachment and of feathers." The idea of a "deceptive appearance" in the feather is negatived by Von Meyer, who states that in his specimen the fibres of the vane can be distinctly traced, and even the small barbules with which they are beset. M. Wagner named the fossil which he examined *Griphosaurus* (Enigma-lizard), and it does not seem that Von Meyer has any reason for supposing the creature to which his feather belonged was of a different nature, although he has given it a different appellation. M. Wagner thinks the discovery of the new fossil may explain the foot prints in the Trias, which have been ascribed to birds, and Von Meyer remarks that in 1824 he pointed out the danger of too closely following Cuvier's theory that a similarity of particular parts indicated a similarity of other parts, or of the whole.

SECCHI ON MAGNETIC AND ATMOSPHERIC PERTURBATIONS.

In a letter to the French Academy, the distinguished Roman observer Secchi, gives a summary of the conclusions he has arrived at respecting the connection between magnetic perturbations and atmospheric movements. This he considers established, first, by the great variations of magnetic elements, and especially in the intensity of the horizontal force, on the occurrence of storms; secondly, by the irregularities which accompany periods of squalls; thirdly, by the great depression of the bifilaire,* and the variations of other instruments which precede, or follow immediately, great changes in the weather; fourthly, by variations of intensity corresponding with variations of the winds; fifthly, by the *aurora borealis*, which, considered as a signal of variation in wind and weather, belongs to the class of phenomena under discussion.

* The "Bifilaire," or Bifilar, is a Horizontal Force Magnetometer, so called from the magnetic bar being suspended by a double thread of silk or wire. Its object is to measure variations in the intensity of the horizontal component of the earth's magnetic force.

The immediate cause of the connection thus traced, M. Secchi ascribes to atmospheric electricity, which, when discharged from the air to the earth, must generate strong currents by which the needle is affected. Such currents, he observes, exist not only during auroral manifestations, but also during storms, and are exhibited by each instrument according to its nature, the galvanometer showing changes in tension, and the compass-needle making known alterations in the total force of the current which passes beneath it. With reference to the questions of whence comes the electricity circulating in the soil, and what is its immediate vehicle, he replies by pointing to the precipitations from the atmosphere. The rain especially, he says, discharges an immense quantity of electricity into the earth, and, in general, it may be said that strong actions upon the instruments only occur after a rainfall has taken place at some point more or less remote, even beyond the limits of the visible horizon. This circumstance may, perhaps, explain the fact that magnetic perturbations indicate approaching squalls. Rain usually produces negative electricity over a considerable extent of atmosphere, and it is itself generally negative, which accounts for the notable diminution of horizontal intensity which precedes squalls. The precipitation of vapour without rain, which often happens between eight and nine on clear nights, and which is accompanied by very strong electricity, may explain the magnetic perturbations which occur at that time, and the diurnal electric period which corresponds with the movements of the horizontal needle may belong to the same class of meteorological facts. Even the *aurora borealis* may be included in this category, as there is a continual fall of ice-needles, almost invisible, but whose existence is clearly shown in the narratives of Polar voyages. Atmospheric electricity on these occasions may, perhaps, be exalted by accessory causes, such as the change which takes place when vapour passes to the state of ice, or by the friction of wind against the little icicles in a dry and very insulating atmosphere, and also by the inductive action of superior regions on the falling and floating particles of ice. These various subjects, M. Secchi tells us, are illustrated in his *Mémoires*, but he does not pretend that magnetic disturbances have no other causes than those indicated in the preceding remarks. Further observations will be made at Rome, and notices afforded in the *Bulletin Météorologique*, published in that city.

It is interesting to know that the instruments used by Mr. Secchi were supplied from the Observatory at Kew.

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ON THE GEOLOGICAL VALUE OF RECENT OCCURRENCES.

BY GEORGE E. ROBERTS.

Not unfrequently in the passing, and by many scarce-heeded, news of the day, facts in the physical condition of the earth's surface are chronicled, which, rightly studied, are of high geological importance. As "Intellectual Observers," we may aid very greatly our comprehension of bygone physical events by seeking out these apparently valueless phenomena of modern times, and comparing their results with those operations of past ages which our acceptation of Lyellian philosophy teaches us were the accomplishments of like ordinary, and, in our day, unregarded means. If these principles rule our daily observations, much that has heretofore been unseen and uncared for will be perceived, and found replete with instruction. Risings and sinkings of the surface will be noted as going on simultaneously in many parts of the British Isles, and the rate of growth—so to speak—of land above the sea, of sandbanks from wind action, of morasses by the extension of Sphagni and other bog-plants, and of tide-covered estuaries into areas of permanent land will become ascertained facts. Observations of this kind are peculiarly easy of record just now in the neighbourhood of London, by reason of the trench-diging into the alluvium of the Thames for the main drainage works, and I notice with much pleasure that one gentleman; officially connected with these works, Mr. Cresy, is taking accurate sections of the depth and variety of character displayed in that alluvial deposit, in the formation of which, during the last 2000 years, man and the river seem to have been co-workers. In the study of these modern physical conditions, a re-action resembling that of the new school of German Bibliopoles, who are collecting and laying up in store the ephemeral publications of the day—the street ballad, the tradesman's bill, and the thousand-and one circulars of social and unionist character which flutter our library tables, seems to have set in among geologists; with this difference—that he who studies human life collects for the learning of the future, for the delight of antiquaries in centuries to come; while the philosopher of Nature collects the new-born rarities of the day that they may aid his comprehension of kindred workings in the ages which are past.

A very notable example of a modern occurrence thus throwing light backwards upon ancient physical story I see in the *Times* newspaper of the 5th April. It is worthy of preservation in a remarkable degree, for it illustrates in a clear and decided manner phenomena of ancient deltas and estuarine

brackish water deposits in Permian, Carboniferous, and Triassic times, whose commingle of marine, fresh water, and terrestrial organisms have puzzled the geologist. This is the occurrence in question.

"The Floods in California.—*San Francisco, February 11th.*—I have just received your letter, which has been double its usual time getting here, owing to our fearful visitation of tempest and flood. We have been shut out from the world ever since the 15th of December last. It began to rain on the 1st of December, and we did not regard it much, for we looked for the annual rains. But the rain—which, as usual, was snow in the mountains—continued the whole of the month of December, and about the middle the mountain snows began to melt, as the rain had actually got warmer. The consequence was that the Sierra Nevadas poured down rivers upon rivers of water, until the whole of that great basin of California which the mountains bound was entirely submerged. The only outlet to this water is the Golden-gate, the entrance to the bay at San Francisco from the Pacific Ocean. Take the map of California, and see where, on the south, the mountains come to a point below Tularo Lake, and then go up north to where they again join at Shasta, and then picture the whole of the immense tract of land they enclose under water, and the bay of San Francisco a vast river, pouring its volumes into the Pacific Ocean by the before-named Golden-gate. Fancy, also, the tides of that ocean having no effect in our bay, and welling up at its entrance, and you will have a feeble idea of the magnitude of the volume of water that has for two months ravaged California. Not a ship could enter our harbour, and only the most powerful steamers could stem the torrent. Sacramento, Marysville, and Stockton, our three principal interior cities, all under water, and all communication cut off with them excepting by boats. Business completely at a stand-still, no goods going up and no money coming down. It was very strange to see the sea for about ten miles around the mouth of our bay. In the interior, about sixty miles from San Francisco, and at the embouchure of the northern rivers, are vast tracts of land covered with rushes and semi-aquatic plants, that go by the name of tulé lands, something like the paddy-fields of India. Well, as the waters rose, these immense morasses rose also, and in process of time, becoming detached, floated away with the current in masses of from 100 yards to half a mile in size, and they all floated out to sea, travelling, some of them, more than 100 miles before their arriving. Once arrived in their grander sphere of action, it was the most extraordinary thing to see the myriads of water-snakes, faithful to their home, twisting and twirling in the salt sea, and to see the water-fowl that screamed over their nests as though warning the islands of their danger, and to see our coast when any of the islands were thrown up on it, and the thousands and thousands of snakes wriggling their way over the shrubless sands that bound it for miles in search of anything to hide them from the wholesale slaughter that sticks and stones, and knives and even guns made among their host. We wanted St. Patrick to come. You know the innate dread we

have of a snake, and you can fancy our disgust, amounting to horror, at this invasion of slimy things crawling upon us. All the salt water fish have left the bay, and all the oysters have, like good men, died in their beds."

Another remarkable modern illustration of ancient work I have lately met with a slight note of in a paper of the day. In a comparatively recent eruption of one of the Icelandic volcanoes, a stream of lava making its way to the sea, caught up and embedded in its flow the recent shells and pebbles of the beach. Some specimens of this lava, lately shown to me by Captain Campbell, contained this beach-debris, and reminded me forcibly of the layers of volcanic ash, contemporaries in time of far gone Silurian ages, which lie inter-stratified with the sea beds they intruded on through Northern Wales.

Another exceptional modern event—may it be the last of its kind! which has been made to do good service in the geological cause was the bursting of the Holmfirth reservoir; by observing the effects of which, in moving huge stones and re-laying the transported material along the course of the flood, Mr. Prestwich was enabled to throw light upon the power and effects of water-action similarly confined in geological times.*

These cases I have noted, however, may truly be regarded as exceptional ones, though by their prominent character their power of teaching is the greater; but, as they illustrate the kind of phenomenon which it will be instructive to study whenever opportunity presents, I have quoted them in illustration of the work. In an excellent paper upon "Trails, Worm-markings, and Tracks," contributed by my friend Professor Rupert Jones to the *Geologist* of last month, much valuable material for study is pointed out, and he shows most clearly, by direct teaching and by inference, that by the use of a modern key we read the Nature-printed hieroglyphs of the past.

Geological Society of London, May 1862.

* *Journal of the Geological Society*, vol. viii. p. 225.

WORK FOR THE TELESCOPE.—PLANETS OF THE MONTH.—DOUBLE STARS.

BY THE REV. T. WEBB, F.R.A.S.

PLANETS OF THE MONTH.

THERE may be a fair chance of getting a sight of Mercury in the evening twilight at the beginning of the month, as he attains his greatest elongation from the Sun, and his dichotomy, or half-moon phasis, on the 6th. A position, however, near the horizon is seldom favourable for the employment of those high powers which are requisite to make out details in an object at that time scarcely 8″ in diameter. Those who possess good instruments equatorially mounted may, of course, always find him (except when too near the Sun) at a more suitable altitude, as his brightness renders him visible throughout the day; and it is in their power to supply one of the desiderata of planetary astronomy, the confirmation of the phenomena discovered by Schröter and Harding at the beginning of this century. These consisted chiefly in a difference in the shape of the two cusps, and in the occasional presence of dusky spots and belts, whence Bessel deduced a rotation in 24h. 0m. 53s. Schröter also perceived slight irregularities of form not only in the terminator or boundary of day and night, but in the circular limb, and a difference between the breadth of the observed and calculated phasis, which last has been confirmed by Beer and Mädler.

Venus is still conspicuous in the mornings, but is becoming gibbous and comparatively uninteresting.

Jupiter is passing away towards the west. The following transits may be looked for, though the planet is getting more distant and smaller, his diameter at the end of the month being reduced to 32″·6.

2nd. Shadow of I. goes off at 9h. 41m. 9th, I. and its shadow, and III., are all on the disc together. I. emerges at 10h. 21m., III. at 11m. 20m., the shadow at 11m. 36m. 12th, Shadow of II. departs at 10h. 25m. 15th, Shadow of IV. enters 9h. 44m. 16th, I. is on the disc from 9h. 59m. to 12h. 16m. III. will be in transit at the same time, emerging at 10h. 19m.; the shadow of I. enters at 11h. 15m. 19th, Shadow of II. enters at 10h. 16m., the satellite 15m. later. 25th, Shadow of I. goes off, 9h. 55m. 26th, II. enters, 10h. 20m. Some of these, it will be seen, are interesting configurations.

Saturn continues to turn to us the dark side of his ring.

DOUBLE STARS.

The rapid advance of summer twilight has somewhat overtaken our work, and we are compelled to defer some remark-

able pairs to a future opportunity; many other beautiful objects are succeeding them, but the nights are so short that the telescope is not likely to be much in requisition: and we shall therefore postpone for the present the description of such as may be equally well seen later in the year, and confine ourselves to a small number, which, from their nearness to the horizon, are passing speedily away, or cannot be observed, during ordinary hours, at any other than the present season.

8. *γ Virginis.* 1‴·6. 77°·9. (1831·38). *round*, (1836·06). 1‴·9. 191°·6. (1843·33). 3″·8. 169°·9. (1858·39). Both 4. Silvery-white and pale yellow, the latter the less brilliant. Struve pronounced them alternately variable; this seems confirmed by some observations of Smyth, Dawes, and Fletcher; and, as Humboldt remarks, probably indicates a very slow rotation of both suns upon their axes. In every respect a most remarkable pair. No stars are more unquestionably binary, and none have run so interesting a course, combining such varied distances and velocities. Cassini II. perceived that this was a double star at Paris in 1720, with a distance of about 7″·5, fully half that of Mizar. Since that time the components have been approaching with a gradually accelerated speed, and after a most rapid perihelion, or rather *periastron*, passage in 1836, have been widening out again, and are now a comparatively easy object, at least 4″ apart. At the nearest appulse, Sir J. Herschel's great reflector at the Cape failed to exhibit any other than a circular disc; and the splendid achromatic at Poulkowa, near St. Petersburg, with an object-glass of about 14¾ inches in diameter, and a power of 1000, was only able just to indicate, what was proved by the undiminished light to the naked eye, that there was no actual eclipse. The orbit has given a great deal of trouble to computers, from the inaccuracy of some of the observations. Admiral Smyth has laboured most diligently in clearing up the difficulties which beset his favourite object; and on the whole Sir J. Herschel considers that the period must lie between 140 and 190 years: about 180 seems the more probable duration.

There is little difficulty in finding γ, from α, Spica Virginis, the principal star in the constellation. Spica is on the meridian about 8h. 30m. in the early part of June, and is the most conspicuous star in the southern sky: γ is the nearest bright star to the right of it, and a little above it. γ, as well as η Virginis a little W. of it, and ζ further off to the E., are all near enough to the equator to measure the diameter of the field ofview.

9. *δ Corvi. Algorab.* 23″·5. 210°·9. 3 and 8½. Pale yellow and purple. Sestini calls the small star white. This pleasing pair is easily found, being that nearest to Spica of the four principal stars in Corvus, and forming an equilateral

triangle with Spica and γ Virginis. As it is now declining rapidly, the search for it should not be postponed.

10. α^2 and α^1 *Libræ*. 3′ 49″. 314°·3. 3 and 6. Pale yellow and light grey. A little after 10h. at the commencement of June, when Spica is beginning to decline towards the S.W., two considerable stars will be seen near the meridian E. of it; the lowest, which lies most to the right, is the star in question; the upper one being β. α is a wide but grand object, owning merely an optical connection. The Sun passes very close to this pair, a little beneath them, during the night of Nov. 5. β Libræ is well worth looking at, on account of its beautiful pale green hue, a very uncommon colour in large stars, though often existing, or induced by contrast, in smaller companions.

EXHIBITION TACTICS.

The opening of the first great International Exhibition created a phrenzy of egotism and self-glorification, and the success of England in so novel an undertaking stimulated other countries to follow in her wake.

The idea was a happy one, and although there may be only two cities in the world in which it could be advantageously carried out on a grand scale, every country which has entered into the industrial stage of development has an interest in securing a periodical repetition of the friendly strife. Stripped of rhetorical exaggerations, the process is a stock-taking of the skill and power which various nations employ in the production of exchangeable goods. Every department is a page of the ledger or balance-sheet, and the objects are so many entries in the complicated account. The whole concern is thus a matter of bookkeeping with things instead of figures, and must be primarily tested by the facility, or difficulty, of arriving at results. In the first Exhibition, making allowance for that want of experience under which all parties suffered, there was a marvellous adaptation of means to the desired end. The building was not only beautiful of its kind, but its details were so arranged as to secure individual convenience while presenting the prospect of a magnificent whole. Moreover, the structure enabled the largest quantity of goods to be examined with an approximation to the smallest quantity of walking about. From such a beginning we ought to have made decided progress in what may be called "Exhibition Tactics," or the art of managing so varied and extensive a display. That we have not done so will be apparent to everybody who remembers the structure in Hyde Park, and pays a visit to the great higgledy-

piggledy at the Brompton end of the town. We will not stop to discuss the inconvenience of selecting a locality accessible with great difficulty to nine-tenths of the inhabitants of the metropolis, and remote from the mass of inns and lodging-houses which visitors frequent. The land was vacant, and must become a profitable speculation for influential jobbers if a large stream of public money could be turned that way. This, in brief, appears to be the history of the foundation of the far-famed "Boilers," which were the precursors of the present scheme. The story may some day be told in full; but our present purpose is less with the site than with the arrangements of the newly-opened enterprise.

As an international undertaking the value of such an Exhibition must depend, first, upon the collections being a tolerably fair and complete representation of industrial skill; and, secondly, upon the facilities afforded by their collocation for the purposes of investigation and comparison. Could exhibitors be persuaded to co-operate in such a manner, objects of the same kind should be placed in series; the porcelain or textile fabrics of England, for example, occupying one side of a gallery, and similar productions of foreign nations occupying the other. In the Picture Gallery at Brompton, "Foreign Schools" fill one portion of the fine suite of noble and suitable rooms, while "British Schools" are exhibited in the other. Here we have an approximate illustration of a good method, although there are certain drawbacks, as the pictures which are first seen on entering the British, from the foreign department, seem to have been selected for their position on account of their not possessing those properties of colour which enable them to be viewed with advantage, while the impression of the continental paintings is still fresh and vivid upon the eye. English art has, moreover, suffered from the snobbishness engendered by the Royal Academy, whose agents have been permitted to thrust their water-colour brethren into an inferior set of apartments, and hang their productions in defiance of everything but that *malice prepense* which the oleaginous practitioners are accustomed to manifest towards their aqueous rivals amongst the wielders of the brush. But notwithstanding these defects, if we were to assume British and foreign art as fairly represented in the two collections, the arrangement offers considerable facilities for the comparison of the two. Very different is the result if we try to ascertain how we stand with reference to other countries in the industrial race. The nave, with its conglomerations of incongruous and oddly huddled together objects and edifices, shows at once that the genius of muddle and confusion animated the Commissioners when they disposed of their space. The building itself is badly adapted to the purpose, because it offers no convenient natural divi-

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sions for a technological display; but its original defects have been aggravated by corresponding imperfections in the Commissioners' minds. As a fashionable lounge, in which promenaders are sure to find something of interest, and do not care whether it be a bronze gate, an equatorial telescope, a case of mixed pickles, or a diamond necklace, the new show may win considerable praise; but it is almost as much trouble to go from Regent Street to the *Boulevard des Italiens* as to discover and follow any given branch of trade in the English and French portions of the large Babel which Captain Fowkes and the Commissioners have made.

Not only is the arrangement bad and abominable in its logical conception, but it is, in the main, ill adapted to do justice to specific portions of the contents. Generally speaking, the eye is greeted on all hands with a confusion worse confounded of incongruous objects, and it is quite a relief to turn out of the clumsy bustle to such a tranquil nook as the little court in which the Mintons exhibit their unrivalled porcelain. "General Jumble" appears to have been the chief manager of the concern, and when we have had proof of the disorderly brains which have presided over the *mêlée*, we shall not be surprised to find minor defects, in full harmony with the confusion which has been so thoroughly attained. Foremost among these lesser grievances is the want of directions where anything is to be found, and the want of labels to explain it when it turns up. At conspicuous and convenient spots, plans of the building should be shown, with references to its contents; a few sign-posts should add their guiding remarks, and in each leading division the public ought to find tables of its contents. In some cases a sufficient description is appended to each article, but as a rule the information is very meagre, and often confined to Russian, Spanish, or some other little known tongue. It is also important to give prices—which is seldom done—as the appearance or quality of an article is only one condition of industrial merit, and an international exhibition ought to afford an easy mode of ascertaining who will supply our wants at the cheapest rate. The meanness of the Commissioners in refusing season tickets to exhibitors has sadly curtailed the number of attendants necessary to display their wares, and give the explanations which visitors require, and in this we may see a warning not to permit private greediness to stand, on another occasion, in the way of the public good.

The intelligence of the Commissioners is illustrated by their treatment of the scientific collections, which have experienced little respect. Dalmeyer, Cooke of York, and one or two others, have managed to obtain a limited allowance of ground floor, for a portion of their exhibition of optical instruments; but on the whole the makers of philosophical apparatus have a right

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to doubt the judgment of gentlemen who seem to consider a superb telescope inferior to a pound of candles, or a first-class microscope below an arm-chair. With reference to this important class of productions neither commissioners nor exhibitors—excepting a few of the latter, such as Smith, Beck, and Beck, with their microscopes—have made any provision by which the quality or use of the objects can be seen. It would, for example, have been very interesting and instructive to compare the performances of undoubtedly first-rate instruments, by expensive makers, with cheaper forms by Parkes of Birmingham and other meritorious manufacturers, who have a benevolent, and we trust to themselves profitable, regard for the poorer student's purse. This want will be felt with regard to articles whose use is well known, but when we come to such novelties as the chronographs in the French dapartment, special arrangements should have been made to illustrate their action. It is interesting to be told that a mysterious-looking combination of brass and steel, locked up in a glass box, can measure the flight of a musket ball to the thirty-thousandth part of a second, and the visitor may consider himself lucky that the label tells him thus much, but far more ought to have been done to make such objects understood.

On the whole the Exhibition looks well for British skill and taste—the chief exception being the management of the concern itself, and we would suggest that the guilty parties should be piled up in a "trophy," so as to show the inhabitants of all countries the sort of people to whom such work ought *not* to be confided when another opportunity comes round.

ACARI IN PHOTOGRAPHIC BATHS AND CHEMICAL SOLUTIONS

In our report of the proceedings of the Microscopical Society, the reader will see an account of the appearance of some acari in a nitrate of silver bath employed for photographic purposes by Dr. Maddox. The occurrence of such a form of life under these singular, and, as might have been thought, fatal conditions, calls to mind the experiments made many years ago by Mr. Crosse, and which were ridiculously misrepresented in many statements current then and since. The simple facts are recorded by Dr. Noad in the first volume of his *Manual of Electricity*, from which we extract a few of the most important particulars. In the course of his numerous experiments on electro-crystallization, the philosopher of Broomfield operated upon a solution of silicate of potash, which he supersaturated by hydrochloric acid, and allowed to fall in drops upon a piece of

porous red oxide of iron from Vesuvius, connected by platinum wires with a voltaic battery. On the fourteenth day he noticed a few whitish excrescences, or nipples, which proceeded to develope filaments, and on the twenty-second day assumed the forms of perfect acari. Mr. Crosse observed, when these facts were commented on: "I never ventured an opinion as to the cause of their birth, and for a very good reason—I was unable to form one." He succeeded in obtaining similar acari in solutions of nitrate, and sulphate of copper, sulphate of iron, and sulphate of zinc; likewise in solutions of silicate of potash, and fluosilicic acid. The latter experiment occupied eight months, when the creatures appeared at the negative pole. Mr. Weekes of Sandwich repeated these experiments with silicate of potash "inverted over mercury, the greatest possible care being taken to shut out extraneous matter, and in some cases filling the receivers with oxygen gas." In these instances the acari appeared after the lapse of more than a year. Dr. Noad made similar trials, and after more than sixteen months found the acari on and about the terminal cells of the battery, but not within the bell-jars. Mr. Crosse repeated his experiments, with greater precaution to exclude extraneous matter, and with the same results; but he discovered that it was necessary, as mentioned by Mr. Slack in the discussion at the Microscopical Society, to furnish the little animals with the means of emerging from the fluid. He noticed that "if he let an acarus fall into the fluid under which he was born, he was immediately drowned," and Mr. Weekes observed the same fact. In another case the acari were developed in an atmosphere of chlorine, but they were motionless, and Mr. Crosse remarked, "whether the chlorine prevented their complete animation, I cannot say."

The nutrition of creatures formed under such circumstances is as difficult to account for as their origin; but the paper in a former number of the INTELLECTUAL OBSERVER on the *Conditions of Infusorial Life*, will suggest many considerations that may be advantageously borne in mind. In remarking upon Dr. Maddox's experiments, Dr. Lankester suggested that the paper with which his vessel was covered may have furnished some nutritious matter for the singular visitants; and he also pointed out the great importance of studying manifestations of life under unusual circumstances.

No mention of the objects discovered by Crosse and Weekes appears under the head *Acarus* in the *Micrographic Dictionary*. A certain portion of the scientific world found their prejudices interfered with; so some misrepresented, and others suppressed what had actually occurred. Dr. Maddox is fortunate in having made his observations when better treatment may be anticipated.

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THE GREAT FOUCAULT TELESCOPE.

M. Léon Foucault has laid before the French Academy an account of the great telescope constructed upon his principle for the Observatory at Paris. He observes that his efforts to obtain large instruments with reflectors of silvered glass could not be deemed completely successful until he had reached dimensions exceeding those of the largest achromatic objectives, and that it was only by way of establishing a claim to the recognition of his plans that he announced the formation of mirrors of 10, 20, and 40 centimetres in diameter. Now, he is able to speak of one nearly 80 centimetres in diameter, having a focal length of 4½ metres,* which has been completed in the establishment of M. Secrétan. This mirror, mounted in a Newtonian telescope, has been at work for three months at the Observatory, performing to the entire satisfaction of the director, M. Chacornac.

The thick glass disc was cast in a curved form (*bombé*), at the factory of St. Gobain, in a mould prepared by M. Sautter, the director of the works for the lenticular lighthouse apparatus, and although possessing sufficient homogeneity for its intended purpose, showed before it was silvered that a flaw had occurred during the process of cooling. On its arrival at M. Sautter's workshops, it was reduced in dimensions by bringing it nearer to the required shape, and by cutting a groove to fix the mechanism necessary for its manipulation. It then passed into the hands of M. Secrétan's skilful operatives, who ground it with a counter piece of glass, 50 centimetres in diameter, assisted by emery and water. This process, which was frequently tested by the spherometer, occupied a week, at the end of which time a fine grained and exactly spherical surface was obtained. Having been thus prepared, it was polished by hand, the polisher employed being 22 centimetres in diameter, and covered with rouge. This polishing was completed by one able workman in another week, and the mirror was changed from the spherical to the paraboloid form. From this moment its success appeared certain, and it was removed, with the necessary tools, to the Observatory, to be optically tested, and to receive the finishing touches.

The frame and stand were made by M. Eichens, the director of M. Secrétan's works. The telescope is suspended from its centre of gravity by two trunnions, resting on two solid vertical columns. It possesses vertical and azimuthal movements, so that it only requires to have its inclination adjusted to the latitude of the place in which it may finally rest, to constitute a veritable equatorial. In consequence of the complaints made

* The metre is 39·3779 inches; the centimetre 0·3937 of an inch.

by the French astronomers of the unfavourable atmosphere of Paris, the new telescope will be placed in an observatory to be erected in the south, and specially devoted to original investigations.

On the 28th ult., M. Le Verrier exhibited to the Academy a drawing representing the double nebula in Canes Venatici—the wonderful spiral formation of which was made known through the magnificent instrument at Parsonstown—as seen by the Foucault mirror. The Abbé Moigno tells us that the drawing exhibits "incomparably more details than those given by Herschel and Lord Rosse." If this be correct, the Foucault telescope must possess an enormous advantage over the old form of reflectors, as the diameter of the new instrument is less than half that at Parsonstown.

We understand that four-inch instruments of this description, in a square mahogany frame, elevated or depressed by a rack movement like that of a reading-desk, may be had in Paris for ten pounds. They are, however, liable to become tarnished, when they need an inexpensive process of repair.

DIALYSIS.

BY W. B. TEGETMEIER.

THE application of the researches of Mr. Graham respecting the diffusion of liquids to the purposes of practical chemistry and the arts of civilization, offers one of the most interesting examples of the eventual tendency of even the most abstract scientific investigations to become practical, and so to aid in promoting the comfort and welfare of mankind. It is almost impossible to imagine a subject offering apparently less practical advantages than does the admixture of two liquids with each other, and yet from the rigorous and scientific investigation of the phenomena of their mutual diffusion, and the laws which regulate its operation, has sprung the new method of dialysis, which promises to revolutionize a very large number of chemical operations, and to introduce new methods of manufacture into the arts that will entirely subvert many existing processes.

The subject is so interesting and so novel in its practical bearings, that it will be desirable to trace its gradual development from an abstract scientific truth to its present useful applications. Mr. T. Graham, the Master of the Mint, has long held a very high position among the most eminent scientific chemists that this country has produced; among other subjects that were diligently investigated by him some years since were the laws which regulate the mutual diffusion of gases. The in-

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quiry as to the rapidity with which liquids of different densities diffused themselves followed almost as a natural sequel to that respecting the gases. Mr. Graham's first experiments on the diffusion of liquids were made by means of what he terms *phial diffusion*, and they were performed as follows:—Solutions of different salts, whose diffusive powers were to be examined, were prepared of equal strength, and phials of exactly the same size and shape were filled with these solutions, and then placed separately under the surface of water contained in much larger vessels, the mouths of the phials being left open. Under these circumstances it was found that a certain proportion of the heavy solution contained in the phial rose in opposition to the attraction of gravitation, and mingled with the water by which the phial was surrounded. In the case of coloured solutions, this diffusion was visible to the eye, and in others it was capable of being proved by analysis. It was found, however, that the solutions of different bodies diffused themselves with very different degrees of velocity. Thus common salt diffused with twice the rapidity of Epsom salts or sugar. These, again, are double as diffusive as a solution of gum; and albumen, or white of egg, in its turn, does not possess one-fourth of the diffusive power of gum, nor scarcely more than one-twentieth of that of common salt.

These experiments were varied in different modes, by allowing the diffusion to take place under slightly varying conditions, but the same general results were obtained. The laws deduced from these phenomena are, that crystalline bodies—such as salt, sugar, nitre, etc.—are much more readily diffusible than those that are amorphous, such as gum, gelatine, albumen, solution of starch, or any substances that enter into combination with water in the same manner that they do.

Hence, with reference to this subject, Mr. Graham arranges substances into two groups: those crystalline in character and readily diffusible in water he terms *crystalloids;* the solution of these is always free from gumminess or viscocity, is sapid, possessing, in a higher or lower degree, the power of affecting the nerves of taste. The other class, whose diffusive power is low, he distinguishes as *colloids*, because gelatine or glue (*colle*) may be taken as their type. The solutions of these substances have no disposition to crystallize, and in the solid form they do not possess flat surfaces, such as characterize crystals, but exhibit an irregular roundness of outline. Their solutions are always gummy when concentrated, and what is strikingly remarkable, they are all insipid or wholly tasteless. In the moist condition they are liable to undergo great changes, and solutions of them in a state of purity cannot be preserved unaltered for any length of time.

A solution of a colloid body such as gelatine is found to

offer scarcely any impediment to the diffusion of a crystalloid throughout its entire mass. This diffusion will also take place through any soft solid with almost equal rapidity; a very familiar example of this fact is shown in the process of salting meat, in which case the rapidly diffusible crystallizable sea-salt penetrates to the interior of the flesh, which is a combination of different colloid bodies, such as fibrin, albumen, gelatine, etc.

Upon the fact that crystalloid bodies possess the power of diffusing themselves through soft solids depends the operation known as *dialysis*, and the construction of the instrument called the *dialyser*. This consists simply of a tambourine-shaped frame of gutta-percha, over which is tightly stretched a piece of parchment paper, which completes the resemblance to that musical instrument. This parchment paper is quite impervious to water, so that no passage of fluid similar to filtration can take place through it. If the dialyser be floated on the surface of pure water, and a mixed solution of a crystalloid and a colloid body be poured into it, the process termed dialysis immediately commences; all the crystalloid matter passes through the parchment paper into the water, and the colloid matter remains behind in the dialyser. As an instance of its action, let us suppose a mixed solution of sugar and gum to be poured into the dialyser, when the sugar passes through into the water below, and the gum remains behind in a pure form. If a mixture of the beautiful aniline dye known as magenta and some burnt sugar or caramel be employed, the passage of the magenta into the pure water is readily observed, the dark-brown uncrystallizable colloid caramel remaining in the dialyser.

Other facts of great interest have been discovered as the results of these investigations. Thus it is found that by means of dialysis, we may obtain pure in solution many substances hitherto regarded as being perfectly insoluble. Amongst these may be mentioned silica, alumina, Prussian blue, peroxide of iron, stannic acid, and numerous other bodies of a similar character.

For example, if a solution of soluble glass, which is formed by fusing silica with an excess of soda, be taken and acidified with hydrochloric acid, the acid unites with the soda, forming common salt, or chloride of sodium, the silica remaining for some time dissolved in a gelatinous or colloid form, mixed with the solution of the chloride of sodium. If, however, this mixture of gelatinous silica and common salt be placed in the dialyser, the salt rapidly diffuses itself into the water in the outer vessel, and the solution of pure silica in water remains in the dialyser. This solution is found to have a feebly acid reaction on test paper, but not to the taste, as, being a colloid, it cannot pass through the membrane of the tongue

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so as to affect the nerves of taste. The solution of silica remains for some time perfectly limpid, but eventually sets into a firm jelly. This alteration may be brought about immediately by the presence of several substances, particularly by any earthy carbonate such as chalk. This solution of pure silica possesses remarkable properties; it is absorbed by gelatinous tissues such as the skin of animals, in the same manner as tannin; and like it converts them into a kind of leather, which possesses the remarkable property of not putrefying when kept moist. In the same manner a solution of pure peroxide of iron may be obtained, by first dissolving excess of the hydrated oxide in hydrochloric acid, and then dialysing, when a colloid solution of oxide of iron remains, that is capable of being gelatinized like the silica.

Prussian blue, which is insoluble in pure water, is capable, when recently precipitated, of being dissolved by the aid of gentle heat in a solution of one-sixth of its weight of oxalic acid, when it forms the well-known permanent blue ink. If such a solution be dialysed, the Prussian blue, is in the course of a few days, obtained in a solution in pure water, and may be rendered gelatinous by the addition of sulphate of zinc and several other metallic salts, as the solution of silica is gelatinized by the addition of carbonate of lime.

Such are a few of the many examples of these remarkable phenomena. They are as yet of too recent discovery to have been applied to many practical purposes, but a vast number of applications at once suggest themselves. In cases of the suspected poisoning of articles of food, the poison, if a crystalloid substance like arsenic, can be readily dialysed and obtained in a pure form, however heterogenous may be the mixture in which it is contained.

Dyeing will be greatly facilitated by steeping a fabric in a pure solution of some colloid dye, which will unite with the animal or vegetable fibre as it gelatinizes.

The purification of many drugs, and the separation of different substances in the chemical arts will be rendered much easier than heretofore. In fact there appears scarcely a limit to the application of this principle. Already, as may be seen by the report of Mr. Church's paper, read before the Chemical Society, and reported in our second number, page 156, dialysis has thrown light upon obscure points in geology, such as the formation of flints and other silicious fossils, and it promises equally to benefit physiological research. In fact, humble and inconspicuous as its phenomena may appear at first sight, it is probable that in its influence on science and art, it will greatly surpass any discovery of late years.

PROFESSOR GAMGEE ON UNWHOLESOME FOOD.

Animal poisons still constitute one of the most obscure problems with which chemistry and physiology have to deal. When the Tsetze fly, mentioned by Dr. Livingstone, kills his victim the horse by a wasting disease, how small in quantity must be the morbific matter, which, working we know not how, deranges the vital processes of nutrition and assimilation, and modifies the condition of all the fluids in the great body of the unhappy brute. When a German village suffers from the influence of the peculiar virus developed in badly prepared sausages, or when a dish of mussels torments the admirers of that questionable variety of mulluscous food, our analysts fail in their efforts to separate the peccant matter from the general mass, and our physicians are not more successful in the endeavour to explain the precise mode in which disease or death may supervene. We look to the general law that "a molecule in motion tends to communicate similar motions to other molecules within its influence," as expressing what probably takes place in the class of facts with which we have to deal; and although we may in some cases be able to discriminate between the varying amount of danger attending different stages of putrefaction, we cannot define the precise conditions in which a decaying substance exists, when it is invested with the highest amount of deleterious power. Offensiveness to the sense of smell is no criterion, because sulphuretted hydrogen, and other gases, which make a violently unpleasant appeal to our olfactory nerves, are capable of existing quite independent of any organic poison, or miasma, which may or may not accompany them according to the circumstances of the case.

When we have to deal with a preparation of arsenic, tobacco, opium, or any substance employed in medicine or the arts, we are able to extract a definite material which has little or no tendency to undergo further change, unless it is brought into contact with other bodies under certain conditions. Thus arsenious acid may be preserved unaltered for an indefinite period; the oil of tobacco, or the alkaloids of opium will remain unchanged in our bottles; but when putrefaction assails an organized structure, the morbific power that is evolved, lies in the peculiar motions and changes which influence the ultimate arrangement of particles, and in the operation which they exert upon other substances susceptible of similar alterations in their condition. There is also another consideration that we must bear in mind, and which results from the complex arrangement of atoms in the organic world, or in products which may be derived therefrom. As an illustration of this complexity, let

us look at the amylaceous and saccharine group of bodies, starting with cane-sugar, in which we find twelve equivalents of carbon, eleven of hydrogen, and eleven of oxygen. Professor Miller gives a list of eighteen substances of this group, exhibiting various elaborate combinations of a multiplicity of atoms of the three elements. In other groups belonging to the animal series, still greater complexity prevails, and as such substances are built up in a great variety of ways, so there is an equal variety in the modes in which they may be taken to pieces, and a change of properties—sometimes a very striking one—is found at every stage, whether of the ascending or descending scale. Thus we can understand how putrefactions—which are regulated modes of resolving complex bodies into simpler forms—may, under different circumstances, afford very different results.

These reflexions will assist in explaining the great dangers which result from animal food in an unsound condition. If disease has changed the normal state of the particles, we may be sure that the food is made mischievous, although we may not, without experiment, be able to say to what extent any particular individual may suffer from eating it.

Professor Gamgee, in an important article on "Unwholesome Meat and Milk,"* classifies the evils of bad animal food under five heads, as produced by (1) Cadaveric venom and animal poisons of undetermined nature, developed spontaneously in health or disease. (2) Animal poisons well known from their effects in creating specific contagious diseases. (3) Organic poisons, the result of decomposition. (4) Mineral and vegetable poisons absorbed into the systems of animals, and which contaminate their flesh and milk. (5) Parasitic animals and vegetables, inducing disease in men. The learned professor is inclined to "regard as one and the same deleterious principle developed in an infuriated and over-driven ox, a passionate woman, the cadaveric venom of the human subject, or that of human beings or animals suffering many hours in labour, or from parturient fever." We may presume that the juices of an enraged philosopher would be quite as dangerous as those of a passionate woman; and in all these cases there is a connexion between a certain mental or nervous condition, and the poisonous character which the solids or fluids assume. Mr. Gamgee says that he has frequently spoken to butchers on the subject, and received from them an account of how they have suffered from cuts received in dressing over-driven animals. In man, he tell us, the meat of such creatures produces violent dysentery, with febrile excitement.

Where specific malignant disease exists in animals, the

* *Edinburgh Veterinary Review*, May 1862.

danger of using their flesh for food is exceedingly great, and very numerous cases of severe disorder and death are on record, both here and on the Continent. With reference to pleuro-pneumonia, which brings so many beasts prematurely to the shambles, it is satisfactory to learn that although the flesh is deteriorated, it "cannot be called poisonous;" and strange as it may seem, the occurrence of this disorder has furnished the milkmen with a profitable mode of carrying on their trade. Professor Gamgee says, "In the city of Edinburgh there are dairymen who never knew what it was to make money until pleuropneumonia appeared. They originally paid £10 or £15 for a rich-milking Ayrshire, which they kept a twelvemonth or more. They now pay £25 or £30 for a fat crossbred short-horn cow, which they calculate on selling diseased within three months from entering their dairy, and they find the latter system most profitable. . . . . They have gone so far as to say, "We do not want disease out of the country; it is keeping everything high."

We need not pursue the subject further, especially as the valuable papers of Dr. Cobbold have exposed the dangers of introducing parasites in company with food. We will, however, observe, on the authority of Professor Gamgee, that *many* persons suffer from tape-worm through indulging in a nasty propensity for eating raw pork. Our benevolence does not prevent our saying, "served them right;" but while such savage feeding may have its appropriate reward, we must enter a strong protest in favour of those who are poisoned against their will.

THE WAYS OF THE ORCHIDS.*

Orchids are universal favourites: the children love to pick them in the meadows, and they occupy the place of honour in the costly conservatory. They combine beauty with grotesqueness, strangeness with elegance, to an extent not paralleled by any other tribe of plants; and now that they have secured an eloquent and erudite interpreter in the person of Mr. Charles Darwin, they make their appearance as Floral Professors, delivering to us the profoundest lectures on methods of adaptation, theories of evolution, and other wondrous mysteries of organization and life. Mr. Darwin is one of the few writers so possessed with his subject as to be incapable of circumlocution. He speaks out of the fulness of his heart and brain, and

* *On the Various Contrivances by which British and Foreign Orchids are Fertilized by Insects, and on the Good Effects of Intercrossing*, by Charles Darwin, M.A., F.R.S., etc. London: John Murray. 1862.

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crowds his pages with rich stores of clearly elucidated, carefully arranged, and for the most part recondite facts. The Origin of Species is always present to his mind: but whatever may be our opinion of the great theory which will hereafter be associated with his name, we cannot lay down his volume without acknowledging that he helps us to know, and teaches us to think. Philosophers have often invented hypotheses, and promulgated doctrines, which tended to darken counsel and limit enquiry, which acted as a poisonous narcotic upon the intellect, and placed a pretended explanation, like a barrier, across the path of truth. In Mr. Darwin's speculations we discover none of this evil tendency. They form no opiate to lull us into repose, but suggest endless fields of investigation, and spur us on to a vigorous collection and examination of facts. In this way they are good. They may be refuted; they may be swallowed up in an ampler exposition of ultimate laws; but whatever their fate, they will have assisted to train fresh bands of keen observers, and they will have scattered far and wide the seeds of scientific thought.

The stories of the orchids belong to the "fairy tales of science." In the structure of these eccentric plants we meet with startling contrivances elaborately combined to produce unexpected results. In the Bee Ophrys alone has Mr. Darwin discovered "perfectly efficient contrivances for self-fertilization," and even then combined with "manifest adaptations" for the occasional transport of pollen from one flower to another. As a rule, these curious plants are dependent for their perpetuation upon humble members of the animal world, and their structure exhibits a combination of peculiar difficulties with still more peculiar facilities, for the accomplishment of the final act of vegetable existence, the production of a fertile seed. For a detailed exposition of these arrangements we must refer to Mr. Darwin's book, but we will endeavour to explain the leading facts of orchid history, and just glance at their value in a scientific point of view. In ordinary flowers, the stamens, supporting the pollen-bearing anthers, surround one or more organs of a different shape, called the pistils. When the right time comes the pollen grains fall upon the pistils, and send forth slender tubes, which reach the ovaries and fertilize the germs which they contain. In "all common orchids there is only one stamen, and this is confluent with the pistil, forming the column." The anther is divided into two cells, which often gives the appearance of their being two anthers instead of one. In common plants the pollen, when ripe, is detached with great facility as a fine powder; in orchids the grains are coherent, tied together in masses by peculiar threads, and "often supported by a very curious appendage called the caudicle" or little tail.

The pollen masses with their appendages are collectively called *Pollinia*, a word which we shall have occasion to use. The orchids are botanically considered to have "three united pistils or female organs." The two lower stigmas* are often confluent, so as to appear as one. The upper pistil exists in a very modified and curious condition, having its stigma converted into the *Rostellum*, of which it is very difficult to give an intelligible description without the aid of a drawing, which time will not allow us to prepare. Mr. Darwin observes: "the rostellum is a nearly spherical, somewhat pointed projection, overhanging the two almost confluent stigmas." It either includes, or is formed of viscid matter, and has two discs to which the pollen masses are attached by means of their caudicles. These organs, as we shall see, have a most important work to perform, and they may be discovered in any common orchid, by removing the sepals, or leaves of the calyx, and the petals or flower leaves, except the lowest, which has the most singular shape, and is called the *labellum*, or lower lip. This lip forms a convenient landing-place for insects, "*it secretes nectar*, in order to attract them, and is often produced into a long spur-like nectary." If an insect alights on the lip, and tries to reach the nectary with his proboscis, it finds the rostellum in the way, and in pushing by it detaches one or more of the viscid discs to which the pollen masses are attached. Mr. Darwin succeeded in imitating this action by introducing a pointed pencil, and on drawing it back the disc was firmly attached. While these discs are in their place a liquid keeps their cement moist, but when they are removed it sets in a few minutes, and causes the pollen masses to be firmly fixed to the intruding body. This is essential to the process of fertilization, for if it slipped on one side or the other it would not come into contact with the right portion of the pistil of the flower to which the insect paid its next visit. Nor would it succeed if it preserved the upright attitude in which the adhesion took place. Let the reader hold a finger upright, and suppose the pollen mass attached to its tip, let him then curve the finger horizontally—that is the position which the anther must attain. This change is effected in about half a minute, by the contraction of the adhesive disc. Thus, while an insect flies from one flower to another, this highly curious apparatus arranges itself exactly in the right direction for its work. Now comes another interesting adaptation, noticed long ago by Robert Brown. The stigma or pistil head is very sticky, but not so tenacious as to pull off all the pollen after a single contact. Its resistance to an insect's return snaps some of the threads by which the

* The *stigma* is the fleshy extremity of the pistil, and may be seated upon the ovary, or elevated upon a stalk—the *style*.

pollen grains are fastened, but it leaves others for another flower to catch in turn. This description applies, especially to *O. maculata*, and similar flowers, but it affords the key to the process which takes place throughout the tribe. In *O. pyramidalis* the viscid disc is single and saddle-shaped, and the labellum, or lip leaf, is furnished with two ridges "expanding outwards like the mouth of a decoy," and which will guide any fine flexible body to the trap which the plant contains. The proboscis of a moth, or a bristle, in an artificial experiment, finds itself saddled with the adhesive disc, and Mr. Darwin gives a drawing of the head of an *Acantia luctuosa*, to whose proboscis seven pairs of pollinia are attached.

There is a highly interesting question of orchid manners not quite solved, although an explanation suggested by Darwin appears likely to prove true. In many orchids no secreted nectar has been discovered, and it was supposed that they were the Jeremy Diddlers of the vegetable world, existing by an "organized system of deception." Mr. Darwin chivalrously endeavours to rescue their morality from so odious a charge, which likewise impugns the sagacity of countless generations of moths, and, after sundry experiments, he arrived at the conclusion that the insects have to bore through a delicate membrane to arrive at the treasured sweets, and that this delay gives the adhesive matter of the discs time to set. In five species he found the honied bait within the nectaries, and in them the cement solidified so quickly that the plant had no need to detain its useful guest.

In the genus *Ophrys*, important varieties of structure are met with, and the motive of the insects for visiting the flowers is not clear, but, nevertheless, their curious intervention is proved to take place. In another great tribe of British orchids, the *Neotteæ*, a new set of difficulties, and special arrangements to overcome them, appear. Thus, in the Marsh Epispactis an insect could enter without touching the rostellum, but when once inside the labellum would spring up, and he would have to back out, and place himself in the right positon for the rostellum to fit him with a membranous cap, bearing the pollen grains. In the Ladies' Tresses, *spiranthes autumnalis*, the rostellum is "a long, thin, flat projection," bearing in its middle what Mr. Darwin terms the "boat-formed disc." The touch of an insect's proboscis, the vapour of chloroform, or a natural change in the condition of the plant, splits a fine membrane, and sets the apparatus free.

In three genera of British orchids, the *Malaxis*, *Listera*, and *Neottea*, "no portion of the exterior membranous surface of the rostellum is permanently attached to the pollinia." The first we shall pass over, but the second introduces us to

new wonders. The *Listera ovata*, or "Tway-blade," derives its English and most expressive name, from the singular cleft form of the labellum. In this tribe "the pollen grains are attached together in the usual manner by a few elastic threads; but the threads are weak, and large masses of pollen can be easily broken off." The rostellum, according to Dr. Hooker, is internally divided into a series of little chambers (*loculi*) which contain and shoot out drops of viscid matter. It is, in fact, a vegetable spring-gun, and the moment it is touched, off goes the sticky shot, carrying with it the pollen it catches in its way. "As the pointed tips of the loose pollinia," says Dr. Darwin, "lie on the crest of the rostellum, they are always caught by the exploded drop. I have never once seen this fail. So rapid is the explosion, and so viscid the fluid, that it is difficult to touch the rostellum with a needle quickly enough not to catch the pollinia already attached to the partially hardened drop." In two or three seconds the cement hardens, and the pollen mass is securely fixed to the object which this vegetable artillery has assailed.

We have thus given a very faint idea of the ways of the British orchids. Of their splendid foreign relatives we must not now speak, nor anticipate the delight which the student will experience in reading Mr. Darwin's book. Such themes remind us of the beautiful picture given by Longfellow, in his *Fiftieth Birthday of Agassiz*, where, reverting to the infancy of the great philosopher, he makes "Nature, the old nurse," take the child upon her knee—

Saying: "Here is a story-book
Thy Father hath written for thee.

"Come wander with me, she said,
Into regions yet untrod,
And read what is still unread
In the manuscript of God.

"And he wandered away and away,
With Nature, the dear old nurse,
Who sang to him night and day
The rhymes of the Universe.

"And whenever the way seemed long,
Or his heart began to fail,
She would sing a more wonderful song,
Or tell a more wonderful tale."

These "wondrous tales" become more wonderful when science endeavours to explain the enigmas which they present. Most botanists would agree with Darwin in tracing the relation which the various parts of the orchids bear to those of ordinary plants. The science of homology, as he tells us, "clears away all mist from such terms as the scheme of nature, ideal

types, archetypal patterns, or ideas, etc. The naturalist, thus guided, sees that all homologous parts or organs, however much diversified, are modifications of one and the same ancestral organ: in tracing existing gradations he gains a clue in tracing, as far as that is possible, the probable course of a modification during a long line of generations. He may feel assured that, whether he follows embryological development, or searches for the merest rudiments, or traces gradations between the most different beings, he is pursuing the same object by different routes, and is tending towards the knowledge of the actual progenitor of the group as it once grew and lived." Following Robert Brown, Mr. Darwin resolves the orchid into five simple parts, three sepals and two petals, and two compounded parts, the column and the labellum. The latter he considers as "formed of one petal and two petaloid stamens of the outer whorl, likewise completely confluent." Those who deny the modification for which Darwin contends would explain the agreements and correspondences which he traces, by a theory of "types;" but he asks "Can we, in truth, feel satisfied by saying that each orchid was created exactly as we now see it, on a certain ideal type; that the omnipotent Creator, having fixed on one plan for the whole order, did not please to depart from his plan; that He, therefore, made the same organ to perform divers functions—often of trifling importance compared with their proper functions—converted other organs into mere purposeless rudiments, and arranged all as if they had to stand separate, and then made them cohere? It is not a more simple and intelligible view that all orchids owe what they have in common to descent from some monocotyledonous plant, which, like so many other plants of the same division, possessed fifteen organs arranged alternately, three within three in five whorls, and that the now wonderfully changed structure of the flower is due to a long course of slow modifications—each modification having preserved that which was useful to each plant during the incessant changes to which the organic and inorganic world has been exposed."

Thus speaks Mr. Darwin in defence of his ingenious scheme, upon which we feel no call to pronounce sentence, because the means of final decision do not as yet exist. To prove inductively what really was the order of the universe in any great group of facts, requires that we should have a complete series of the facts before us, which in this case we have not. To prove deductively the correctness of any hypothesis, demands the previous establishment of the general laws from which the particular phenomena spring, and this has not yet been done. We are entitled to say to Mr. Darwin: we suspend decision with more or less doubt against you, because, as you know, your

proof is incomplete; but we are not justified in demanding the production of a particular kind of evidence, unless we can show that it exists and might be obtained. We may, for example, logically say, "If your theory be true, connecting links and transition forms must have existed during the lapse of time, and until you can prove that they did exist, we are not convinced." But if we ask for so many connecting links within certain limits of time or space, we are bound to show the probability of their having existed within those limits if ever they existed at all.

Fortunately, it is not necessary that we should make positive affirmations concerning things of which we know little, or nothing at all; and if, speaking physically, science enlarges the sphere of action assigned to secondary causes, our conception of the First Cause becomes grander in proportion to the precision and complexity of the work which we see performed. If the orchids be only modified descendants of a more ordinary kind of plant, what a wonderful picture of powers, forces, and relations is presented to our view. How inconceivable the Wisdom which established and guides the whole, and which secured the occurrence of the most skilful and amazing changes of parts and organs, precisely at the right time. If a little flower moved a great poet to "thoughts too deep for tears," surely the "Ways of the Orchids," may excite a reverential contemplation of Nature, far removed from the arrogant dogmatism which prejudice and ignorance so readily beget.

THE HAIRLESS MEN OF AUSTRALIA.

The following curious account of the Bald men of the Balonne is taken from the *Sydney Empire*, Feb. 19th, 1862, and as it suggests very curious inquiries, both ethnological and physiological, it is to be hoped that further information may be obtained.

"It is now some few years since a report first obtained currency, that, far in the Western interior, beyond the Balonne River, a tribe of aboriginal natives existed who exhibited remarkable physical distinctions from those with whom explorers and other colonists have so long been familiar. It was said that the natives in question were entirely destitute of hair, even on the head, which was as bald as a billiard ball. Other remarkable peculiarities were also mentioned, but the absence of ocular proof led most people to doubt them, and it was pretty generally believed that either the blacks alluded to were merely suffering from some cutaneous disorder, or the tale was one of those bush 'yarns' which outlying settlers think it no harm to hoax the townsman withal. Yesterday, however, we had an op-

portunity of ascertaining that all the statements were perfectly true. Mr. M'Kay, a gentleman just arrived from the Balonne River by way of Rockampton, called at our office with one of these natives. He is a young man, according to Mr. M'Kay's belief, only about sixteen or seventeen years of age, but certainly looking much older. His head is entirely destitute of hair, nor is there any trace of hirsute honours on his body. There was a black, ingrained appearance on the scalp as if the roots of hair remained, but Mr. M'Kay states that this is merely the traces of a dirty cloth which he was in the habit of wearing on his head. There needed not, however, this remarkable destitution of hair to show that the individual before us was the type of a race utterly differing in physical peculiarities from the ordinary aboriginals of Australia. The whole contour of the face, form of the head, expression, colour of skin, and listless, almost sullen attitude, at once suggested the Mongolian. His physical development is far inferior to that of the healthy aboriginal found in other parts of Australia. The large, rapid eye, thick lips, broadly-spread nose, and deep brown skin were all absent. The peculiarity of the face was most evidently Chinese, and the eye confirmed this impression. The skin of this interesting stranger is precisely of that deep yellow-brown shade which might be expected in a descendant from Chinese and aboriginal Australian parents. The party to whom he belonged, for there is no clear reason for calling it a tribe, appeared to inhabit the country to the north-westward of the Upper Warrego. Mr. M'Kay had not seen more than six or seven of them at various times, one, at least, of whom was a woman, and one man was much taller and more strongly proportioned than the specimen brought to our office. The whole circumstances of the case render it extremely probable that these remarkable people are the descendants of Chinese fisherman, who having, years ago, landed or been cast away in the Gulf of Carpentaria, or on the Australian coast of the Arafura Sea, have remained with the Australian aborigines, and transmitted the physical peculiarities of their race to their descendants."

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

ROYAL GEOGRAPHICAL SOCIETY.

ASCENT OF THE YANG-TSE-KIANG.—Dr. Barton's paper gave an account of a journey made up this river. It was intended that the exploration should continue as far as possible up the Yang-tse, and should then traverse Thibet, cross the Himalaya range, and descend into the plains of Hindostan. The disturbed state of the country, however, rendered the journey impossible beyond the town of Ping-Shan. This town is situated on the Yang-tse-kiang, in the province

of Sze-chuen (hitherto known to Europeans only by the reports of the Jesuit missionaries), and is 1800 miles above Shanghai. Up to this expedition, only 900 miles of the river have been known.

The paper gave a most interesting account of the river valley, and described the mountainous country through which the river flows in its upper and middle course to 360 miles above Han-kow. It was shown how, by means of the tributaries of this river, water communication is kept up between the ports at the mouth, and the north-west provinces, Canton and Pekin. With the last mentioned place, intercourse is carried on by means of the imperial canal, which crosses the river at Ching-kiang-foo.

The alluvial soil of the river-valley above the Tong-ting lake, produces wheat, beans, and millet in abundance. In its higher course the river passes through deep gorges, where the bed is narrow and the water very deep. In one of these, the E-chang gorge, the cliffs rise abruptly above the river to a height of 500 feet. The mountains are covered with oak, fir, and cedar trees. The hill sides are subject to terrace cultivation, and for a long distance, about 200 miles, the principal objects of culture appeared to be the poppy and tobacco. The sands of the river are washed for gold, and coal and iron are worked to a considerable extent.

The lower part of the Yang-tse-kiang was in the hands of the Taepings, and everywhere evidences were seen of the desolation and utter ruin that they had brought along with them. The city of Nankin, which had a population of 600,000, was reduced to about 2000 inhabitants. The town was in ruins, the far-famed Porcelain Tower a heap of fragments, and the gardens and fields overgrown with weeds.

Farther up the river, where the people were undisturbed, there was a dense population, and all the evidences of Chinese industry. But on reaching the province of Sze-chuen, the travellers found another insurrection—totally unconnected with that of the Tae-pings—which rendered it impossible for them to proceed, Almost at the farthest point reached, the party were met by some native Christians, who welcomed them, and took them to their service in a little chapel, meanly furnished. For this the excuse was made that the rebels of Sze-chuen were unfavourable to the Christians.

The results of the journey may be summed up as follows: 1800 miles of the river had been ascended, that is, 900 miles farther than any European, except the Jesuit missionaries, had been; coal in very large quantity had been found, enough to supply all steamers that should be engaged in the navigation of the river; the river had been found to be navigable for small steamers up to the point reached by the exploring party; the whole of the valley had been found fertile, producing corn, tea, silk, and opium; and lastly, it had been found that the province of Yunnan forms the right bank of the river, and is not, as it has been represented on older maps, about 100 miles to the south of it.

The imperial rule is by no means general in China. In the east there is the rebellion of the Taepings; in the south there are

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insurrections of the Mussulman population; there is the rebellion in Sze-chuen, and there are others in other provinces.

Consul Parkes said that the Taeping rebellion broke out in 1849 in the province of Kwang-si. Its effect had been to desolate all the flourishing and populous provinces which had been overrun. The rebels have no flotilla, and cannot hinder the navigation of the Yang-tse-kiang. As a proof of the probable value of the future commerce of that river, it was stated that from April to December of last year, 152 foreign vessels passed up from Shanghai to Hankow, and 170 junks in foreign employ; and it was estimated that trade to the extent of £10,000,000 sterling would be done there during the present year. The probable causes of such wide-spread insurrections are the pressure of population on production, the absence of poor laws, and the inefficiency of the police. The government tried to rule by moral suasion, but the people were not obedient. The Chinese government is a stationary despotism, with no vigour, and has been for 1200 years in entire isolation from the rest of the world. Had it not been for the Tartar invasion 220 years ago, matters would have been worse. Now, the hope is that intercourse with western nations will give life.

The Chinese were acquainted with the use of opium long before the British took it to them, and they only prefer what is imported, because it is better than what is home-grown.

The Jesuit missionaries have been very successful; but when they were first established in China, in the sixteenth century, they were high in court favour, which they did not lose till they concerned themselves in political intrigues in 1720. At present it is reckoned that there are 400,000 Roman catholics, 12 bishops, 80 missionaries, and 90 native priests. The missions cost 59,000 dollars a-year.

Up to the present time Protestant missionaries have laboured under the disadvantage of being confined to districts within thirty or forty miles of the ports. Now, however, they will be able to do more; and Dr. Lockhart's medical mission at Pekin has been already most successful.

The Fiji Islands.—These islands are at present peculiarly interesting from the fact that the chiefs wish to cede them to the British, and that the question of their acceptance is now under consideration. Dr. Bensusan's paper gave an account of the group. There are two large and many small islands, 180 in all. They are of volcanic, or of coral formation. The larger islands are hilly, the heights rising from 2000 to 4000 feet. The chief exports are cocoa-nut oil, tripang, sent in large quantities to China, tortoise, and pearl shell. The islands are well adapted to the growth of cotton, and the produce of this plant has been as much as 800 lbs. to the acre, which is more than the average of South Carolina and Georgia. The harbours are extensive and numerous, and afford good anchorage. The Fiji (or Viti Islands as they are more correctly called) would afford return cargoes for ships coming home from Australia.

Vancouver's Island and British Columbia.—Captain Mayne, R.N., read a paper on a journey across Vancouver island, from the New Saw Mill settlement, established at the head of the Alberni Canal to Nanaimo, the coal depôt of the island. During this journey many difficulties were encountered. At one place snow-covered mountains obstructed the passage, but on the whole the country was found good; and a road between these settlements would be highly advantageous to the colony. It was also stated that along the courses of several rivers of the island there are large extents of land fit for ploughing without needing previous clearing. A paper on British Columbia, by Mr. Kelly, was read. It gave a detailed account of the mineral wealth, the extensive gold-fields, splendid forests, and fertile land of this colony. The Fraser River is open to vessels drawing from eighteen to twenty feet at all time of tides; and after the channels are buoyed and lighthouses erected, it will be navigable as far up as Yale. The great obstacle at present to the development of the wealth of British Columbia is the difficulty of getting emigrants to it from England. Mr. Kelly proposed to make the trade of this colony flow through British territory, *viâ* the Vermilion Pass, Pembina, and the Grand Trunk Canadian Railway. The Vermilion Pass will present little difficulty in road-making, the grade being only 1 in 135. New Westminster might be reached from Portland (Maine) in twenty-five days. Captain Mayne and Dr. Ray both said that, at present, the route by the Rocky Mountains was almost impracticable. The passes through the mountains are much encumbered with wood; and in crossing the prairie ground between the Red River settlement and the Rocky Mountains, game and buffalo are not abundant, and, indeed, not always to be found. In speaking of the richness of the Cariboo diggings, Captain Mayne said that he had been told of three men, who, after one day's work, took out nearly 195 ounces of gold in nuggets of large size.

ZOOLOGICAL SOCIETY.—*May* 13.

Gigantic Pair of Antlers.—Mr. Louis Fraser exhibited a pair of enormous antlers, the property of Lord Powerscourt, who forwarded the following note respecting them:—"This pair of horns was bought for me by the Hon. Julian Fane, at Vienna, about six weeks ago. The history he got with them was that they belonged to a person who lived near Kronstsdt, in Transylvania, and they were sold out of his Schloss (Palace) at his death, and bought by a travelling merchant, who again sold them to a burgher of Vienna, from whom Julian Fane bought them for me.—"Powerscourt." The weight of this pair of antlers is 74lbs. The height in a direct line four feet three inches, but following the curve of the antler, five feet eight inches, the greatest width being five feet five inches, and the number of points on which a cap can be hung, the usual test as to what constitutes a point, is forty-five. These

appear to be the largest horns on record. The antlers shed by the Wapite deer in the Zoological Society's garden rarely reach half the weight above stated.

MICROSCOPICAL SOCIETY, *May 14th.*

Messrs. Smith, Beck, and Beck, exhibited an instrument called the "Museum Microscope." It consists of a large cylinder of brass, resting on a cast-iron frame, and surmounted by a microscope body. The great cylinder contains a series of small cylinders, each carrying numerous slides, exceeding five hundred in all. One slide cylinder after another is brought under the microscope; and by turning a milled head the objects are presented in succession—the name of each being conspicuously shown. The microscope is furnished with three powers, any one of which may be brought into action by a simple mechanism. The instrument, which is only adapted for transparent objects, presents great advantages for public exhibitions, as its movements are easily understood, and there is little chance of unskilful observers doing any harm to the objects or the machinery.

Mr. Webb presented to the Society a slide containing the first chapter of the Gospel of St. John, written by himself with a machine of his own invention, in the 500th of an inch. Mr. Ross presented a fine bust of his late father.

Dr. Leary read a paper on some new flukes. Mr. Smith described his method of taking micro-stereographic drawings; and a paper was communicated by Dr. Maddox on some living organisms found in a nitrate of silver bath used for photographic purposes. They appeared to be mites, bearing a strong resemblance to the *Acarus Crossii*. From the circumstances detailed their appearance could not be accounted for, nor was it at all clear what they could find to live upon. The nitrate of silver was in the proportion of forty grains to the ounce; a sheet of paper was usually laid over the vessel and the cover pressed down.

GLEANINGS FROM THE INTERNATIONAL EXHIBITION.

The duties of the writer of the following short paragraphs necessitates his careful examination of almost every article in the raw material and scientific classes at the International Exhibition. He proposes to utilize the advantages he possesses by bringing before the readers of the Intellectual Observer a series of notes on those objects of scientific interest that may be most worthy of notice, or that from the magnitude of the collection might be liable to escape observation.

The present series is confined to the first four classes, those including what are termed raw materials. All the objects alluded to are contained in the eastern annexe or its approaches.

Aluminium Bronze.—The applications of aluminium and alu-

minium bronze to the purposes of ornamental art as well as to the manufacture of objects of utility is strikingly exemplified in the magnificent series of articles exhibited by Bell Brothers (18). One of the strangest properties of this singular alloy of copper and aluminium is that after being forged it is annealed by precisely the reverse treatment to which iron is subjected, as it is heated to dull redness and then plunged into cold water.

British Gold and Silver.—The value of the precious metals that may be obtained from British sources is but beginning to be appreciated. Cox of Derby (71), shows a mass of silver weighing nearly 2000 ounces, obtained from lead ores, and the Vigra and Clogau Mining Company (383), exhibit ingots of gold of 123 ounces, showing the weekly yield obtained from these mines.

Tensile Strength of Iron.—At the end of the case of iron manufactures from the Round Oak Iron Works of Lord Dudley (332), is a piece of cold rolled plate, having a sectional area of one square inch, that was tested at the government dockyards, and was found to support the enormous strain of upwards of fifty tons before it broke. This inch bar of iron would have supported a greater weight than that of 700 persons.

Sheet of Metal One Mile in Length.—A sheet, or shaving of cut lead, one mile in length, and having an area of nearly 800 square feet, is exhibited by Wilmhurst's Patent Foil Company (410). This is, perhaps, the longest sheet of metal ever manufactured.

Rail One Hundred and Seventeen Feet in Length.—In the open court adjoining the eastern annexe, may be seen a rail 117 feet long, rolled by the Butterley Iron Company in one length.

Gigantic Masses of Rolled and Forged Iron.—Among the stupendous masses of iron exhibited may be mentioned the forged double crank shaft, weighing twenty-five tons, and designed for the engines of one of the new armour-plated vessels now building. Forged armour-plates are also shown more than six feet in width, that can be manufactured of any thickness and almost of any length required, and a rolled boiler plate 112 square feet is exhibited.

Amorphous Phosphorus and its Practical Applications.—The discovery that phosphorus is capable of existing in a condition in which it is no longer spontaneously inflammable but capable of being exposed to the air without change, or danger of ignition, is turned to account by Bryant and May (488), who exhibit matches which cannot be ignited by friction anywhere except on the prepared surface of the box. The secret of the contrivance being that the chlorate of potash compound, tipping the match, is destitute of phosphorus, which in the amorphous form, is placed on the sand paper, hence these matches are perfectly safe from accidental ignition, and moreover are not poisonous.

Pseudomorphous Crystals.—Mineralogists are acquainted with many substances which crystallize in forms that do not belong to them, or are pseudomorphous; the formation of these crystals is

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well illustrated by the soda manufactures shown in the building. Gigantic and beautiful crystals of bicarbonate of soda are exhibited having the exact form of the common carbonate when crystallized with ten equivalents of water. They are produced by exposing the latter to the action of carbonic acid, which is absorbed, and changes the chemical constitution of the substance without affecting its physical form, hence results one salt having the form proper to another.

Thallium, the last New Element.—The last new element which has been recently discovered, in extremely minute quantity, in some ores of sulphur, by the aid of the spectroscope and process of spectrum analysis, is shown by its discoverer, Mr. Crookes; several of its compounds are also exhibited. Thallium gives a single, bright green line in the prismatic spectrum, hence its name from Thallus, a green branch.

Utilization of Mixed Cotton and Woollen Rags.—A very ingenious method of utilizing a waste product has been devised by Mr. Ward, and is illustrated by his specimens in case 618. The rags of mixed cotton and wool such as the ordinary *Orleans* and *barège* and many fancy Norwich goods, are submitted to the action of superheated steam, which is of such a temperature as completely to char and destroy the animal fibres without effecting the destruction of the vegetable tissue, which can consequently be employed in paper-making, the charred remains of the wool being useful as manure.

Aniline and Coal Tar Dyes.—The production of the valuable dyes derived from coal tar is illustrated by a beautiful series of specimens showing the various stages of the manufacture, and a block of solid aniline purple, or mauve, about one thousand pounds in value, containing sufficient amount of colouring material to dye hundreds of miles of silks (581). These beautiful specimens are exhibited by Mr. Perkins, the discoverer of the colours. Splendid specimens of crystallized rose aniline or magenta are shown by Messrs. Simpson and Nicholson (600). This colour, which in the solid form is of a lustrous metallic green, resembling the wing-cases of tropical beetles, is crystallized around wires, arranged into large crowns.

New Process for Preserving Uncooked Meat.—Specimens illustrative of Jones's process of preserving of raw meat, as joints of beef, fowls, salmon, etc., are exhibited (795). The plan adopted is to extract the atmospheric air by means of a vacuum, and then to admit nitrogen or azote. This permeates the substance of the flesh, and prevents the putrefactive changes which would otherwise ensue.

Multiple Telegraph Cable.—The Gutta Percha Company exhibit a specimen showing the perfection of their mechanism and workmanship. It consists of a cable half an inch in diameter, which contains forty-nine telegraphic wires, each perfectly and separately insulated, and capable of conveying its own electric current without influencing, or being influenced by, the currents passing along the other wires.

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ADHESIVE STRENGTH OF GLUE.—The tensile strength of the iron exhibited has been already noticed; one of the makers of glue shows a wooden bar having the same sectional area of one square inch; when sawn across and united by glue, the joint resisted a tensile strain of 504 lbs. before breaking, a remarkable contrast to the 50 tons supported by the iron.

NOTES AND MEMORANDA.

THE COMPANION OF SIRIUS.—It appears that Dr. Peters has reconsidered this subject, and written to *Cosmos* to the effect that the newly-discovered star may be that body whose existence was first conjectured by Bessel. Mr. Bond has published in *Silliman's Journal* some additional particulars, and he states that Mr. Safford having concluded his calculations, agrees with Dr. Peters in assigning fifty years as the period of the revolution of Sirius. M. Chacornac estimates the light of the companion star at one ten thousandth of that emitted by Sirius, and M. Le Verrier calculates its bulk at a third or a fourth of that of the larger orb.

NEW POLARISCOPE OBJECT.—Mr. Marston of Ludlow recommends a double oxalate of chromium and potash. He dissolves in hot water one part bichromate of potash, two binoxalate of potash, and two oxalic acid. A specimen he has been kind enough to forward to us exhibits splendid effects, which are improved by the selenite stage. He recommends viewing the crystals with a half-inch. We succeeded well with a two-thirds.

MR. HIND'S NEBULA FOUND.—Messrs. Winnecke and Otto Struve saw this curious variable body through the great instrument at Pultowa on the 22nd of March. Its brilliancy is now little inferior to that of the comet of 1861, which remains visible. On the 29th of last December the nebula was likewise seen at Pultowa.

INSECT DESTROYER.—A weak solution of chloride of lime is said to preserve plants from insects if sprinkled over them. Flies are also got rid of in stables and other places by scattering chloride of lime on a plank. If the same substance is mixed with half its weight of some fatty matter, and a narrow band of the composition smeared round a tree, insects will not pass it.

THE SILKWORM DISEASE.—The *Archives des Sciences* gives an account of an important discovery of the nature of this obscure and mischievous complaint, which, without changing the external appearance of the silkworms, destroys their value by attacking their internal organization, and especially causing an atrophy of the apparatus which secretes the silk. The microscope disclosed the supposed morbid element in the shape of small bodies which M. Cornalia designated oscillating corpuscles, and to which M. Guérin gave the inappropriate name of "hematozoids." M. Lebert considered them unicellular plants, and Professor Chavannes called them "crystals." M. Cornalia announced, in confirmation of his view, that when worms which died of the disease were exposed to moisture their bodies were covered with a mould whose spores had a remarkable resemblance to the "oscillating corpuscules." But whatever be the real nature of these bodies, their presence is a certain sign of the existence of the disease, and M. Vittadini has made the curious discovery of their appearance in the egg. He tells us that, as soon as the development of the embryo commences, its tissues in diseased specimens are filled with the oscillating corpuscules. He has also ascertained that the diseased eggs are developed more slowly than healthy ones, their complete evolution requiring four or five days, and even more, instead of two or three. He, therefore, recommends the destruction of all the backward progeny; and, confirming the observations of Marshal Vaillant, M. Quatrefages, and others, he advises the culture of the worms in the open air. M. Chavannes states that if the eggs are developed in the open air upon trees furnished with a metallic trellis, upon which the process may take place, a complete regeneration of the race can be readily effected.

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PHOTOGRAPHIC HINTS.—M. Civiale has obtained fine impressions by employing a mixture of one part of wax and four of paraffine. Major Webster Gordon employs equal parts of the iodide and bromide of cadmium in the preparation of collodion for instantaneous photographs, which he developes by means of pyrogallic acid. M. Reynaud remarks, that when great sensitiveness is required, the collodion should contain but a very small quantity of free iodine. He also states that bromide of silver is, in comparison with the iodide, more sensitive to the least refrangible colours, red, yellow, etc. Bromides of ammonium and cadmium possess this property in a still higher degree. Bromide of potassium communicates to collodion a delicacy similar to that produced by its iodide. For moist collodion he employs three or four grammes of the bromide to twelve grammes of the iodide, and one *litre* of normal collodion.

NEW CHRONOGRAPH.—*Cosmos* gives a brief account of an instrument invented by Captain Schultz which is able to measure the duration of phenomena which only last the five hundred thousandth of a second. It consists, first, of a drum, about a metre in circumference, having its surface silvered and covered with lampblack before the experiment begins. A double motion gives this drum three turns in a second. Its next portion is a "diapason" giving five hundred vibrations in a second; its third portion is a point fixed on the "diapason," which traces a sinuous curve on the drum; and lastly, it has a small electrical apparatus which marks by an induction spark, the beginning and the end of the phenomenon, which is investigated. "That which characterizes this instrument is the great length of the mark on the cylinder which represents an infinitesimal duration;" and it is affirmed that it recently measured the time occupied by a projectile fired from a rifle in traversing a few centimetres. Each centimetre is equal to 0·3937 of an inch.

DIATOM CYSTS.—Madame Lüders states the cysts enveloping certain specimens of *Coconema cistula*, *Gomphonema*, etc., are not, as has been supposed, vesicles formed by the diatoms, but Amœbæ by whom they were assailed. She found that an Amœba occupied one or two hours in surrounding a group of Synedra. This lady is also of opinion that observers have taken for spores of diatoms small infusoria which are often developed in their interior.—*Mohl Botanische Zeitung, Bibliothèque Universel*, Feb. 1862.

LEECHES.—Dr. Ebrard observes that an adult leech gorged with blood requires nearly eighteen months in a state of captivity for the process of digestion. Young and free specimens accomplish the same task in six weeks or two months.

PECULIAR GREENS.—In a recent paper on dyeing, read by Dr. Crace Calvert, at the Society of Arts, he called attention to the curious fact that the greens produced by dyeing silks first with Prussian blue and then in an acidulated bath of carboazotic or picric acid, appeared green in artificial light, while the greens obtained with indigo and picric acid turned blue under the same conditions. He also stated that the Chinese vegetable green Lokao, which M. Charwin has succeeded in obtaining from the European seed *Rhamnus Catharticus*, is the only substance he was acquainted with capable with suitable reagents of producing the seven colours of the spectrum.

IMPROVEMENT IN KELP MANUFACTURES.—Mr. Stanford dries the seaweed he operates upon, and presses it into cakes, which he carbonizes at a low red heat in iron retorts, collecting the volatile products, among which he finds ammonia, wood spirit, and paraffine oil. By this process a considerable loss of iodine is prevented, and a larger quantity of useful products obtained. He hopes that the masses of weed thrown up on the south coast of England will in future be utilized, especially as the deep water weeds from the Atlantic are found to be the most valuable.

DEVELOPMENT OF CORAL.—In No. II. *Intellectual Observer*, p. 167, we gave a short account of the investigations of M. de Lacaze Duthiers on the growth of coral; we extract the following additional particulars from *Comptes Rendus*, 3rd March, 1862. The embryos, which are vermiform, swim with their tails foremost and mouths backwards, and after continually bumping against various objects, they fix themselves, and give up a locomotive life. They are most disposed to come into contact with other bodies when their elongation ceases, and they begin to lose the worm-like form. In their process of growth they become shorter and

broader, and then the slender extremity which carries the mouth recedes in the centre of a circular disk or pad, from which the rudiments of eight tentacles speedily grow. In addition to multiplication by ova, the coral polyps increase by budding, and thus build up their well-known reefs. The living coral is composed of an axis, or central solid portion, and the external soft polypiferous layer, which M. Duthiers tells us owes its colour to the multitude of spicules which it contains. In tracing their growth it appears that, after exchanging the elongated worm shape for the disk form, the young coral animals pass quickly from white to rose colour, and then to a lively red, as the calcareous corpuscules are formed. They have as yet no axis, and the solid portion is represented entirely by the corpuscules. The little creatures are elegant objects with their expanded tentacles, although exceedingly minute—a quarter or half a millimetre in diameter. They are at first single, but bud freely, and as each bud repeats the same process, a large compound family is soon produced. At first the solid particles are uniformly distributed through the tissues, but after the budding they multiply in particular directions, and are surrounded and united by a calcareous cement, and thus the axis is produced. This mode of producing a polypary is not restricted to the individuals who commence a colony, but takes place at the extremities of old branches, where juvenile members always exist, and it always happens that towards the base of adult branches the cement is deposited faster than the corpuscules (spicules), and in regular concentric layers.

A Modern Cyclops.—Doctor Depaul lately exhibited to the Academy of Medicine at Paris the body of an infant, which lived a short time. It had only one eye in the centre of its forehead. The nose was wanting, and the mouth, reduced to a small orifice. The mother of this monstrosity was twenty-three years old, and had previously given birth to a properly-formed child.

Vegetable Amœboid Bodies.—Dr. Hicks states he has verfied his observations on the Amœboid state assumed by zoospores of Volvox Globator. He also finds that when mosses are kept in water, the endoplast of the elongated cells in their radicles is apt to become detached, and collect in ovoid masses, which comport themselves like Amœbæ. Watching some for several hours, he found the whole exterior to become covered with minute cilia.—*Quarterly Journal of Microscopic Science.*

Dr. Beale on the Tissues.—In summarizing his conclusions, Dr. Beale regards every living structure as composed of matter *formed* and matter *forming*. The latter he denotes as "germinal;" a cell he describes as matter in these two states. The "germinal matter" sometimes corresponds with the "nucleus," in others with the "nucleus and cell contents," in others to the matter lying between the "cell wall, and the cell contents," in others to "intercellular substance," or to the fluid or viscid material which separates cells, nuclei, or corpscules from each other. Thus the nucleus of the frog's blood corpuscle is "germinal matter," the external red portion being "formed material."—*Quarterly Journal of Microscopic Science.*

A Portable Styptic.—The *Moniteur des Sciences Médicales* recommends country surgeons and others to soak amadou or German tinder in a solution of perchloride of iron of a density about 1·250. It should then be dried in the sun and be rubbed between the hands to restore its suppleness and porosity. Small pieces applied to leech bites soon stop their bleeding. They may be held in their place by strips of plaister.

New Alloys.—The cannons recently cast for the Austrian navy are composed of copper 600 parts, zinc 382 parts, iron 18 parts. This alloy is reported to be excessively tenacious, and easy to forge and drill. It is called after its inventor, Aich metal. We also notice in *Cosmos* a description of an alloy of block tin 375 parts, nickel 55, regulus of antimony 50, and bismuth 20 parts, which M. Trabuc of Nismes proposes as a substitute for silver, as it resists the action of vegetable acids. It is prepared by placing in a crucible one third of the tin, together with the nickel, antimony, and bismuth; over this is laid another third of the tin, and above that a layer of charcoal. The crucible is then closed and brought to a reddish-white heat, and its contents examined with a red-hot rod of iron to ascertain

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if the nickel is melted and the antimony reduced. The last portion of tin is then made to pass through the charcoal, and the mixture well agitated.

THE NEW ROTIFER.—Professor Williamson, in calling the attention of the Manchester Literary and Philosophical Society to the *Cephalosiphon Limnias*, described in the *Intellectual Observer* for February, noticed its possessing only one calcar, whereas the floscularia, when furnished with them, have two, and he suggested the importance of ascertaining whether two existed in the primary condition, and one was suppressed in the process of development.

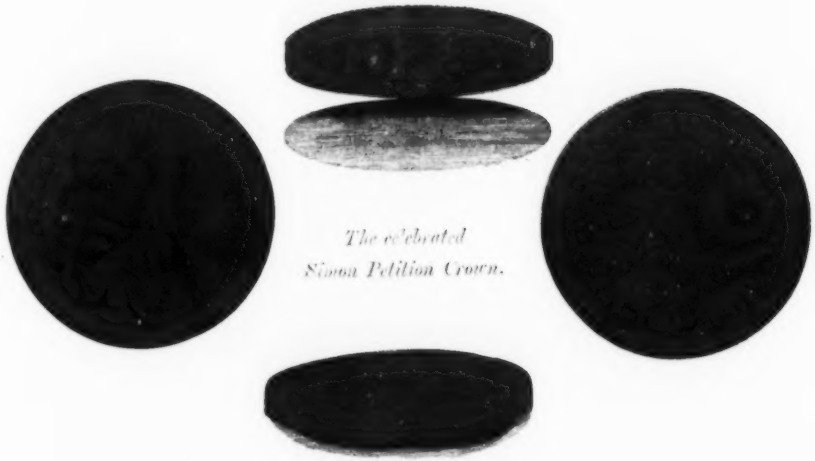
CRYSTALLIZATIONS FOR POLARISCOPE.—Mr. Davies read a paper to the above Society, showing how beautiful arborescent forms could be obtained by taking a salt like the double sulphate of copper and magnesia, drying a portion on a glass slide, fusing it in its water of crystallization, then allowing it to cool slowly. Starting points for groups of crystals could be obtained by touching the film with a fine needle.

THE BRIGHTON WELL.—After digging to the great depth of 1285 feet, water was obtained on the 16th of March. It burst up suddenly with great violence, and a loud report, through the lower green sand, which had been reached in the excavation, and rose more than 800 feet in thirty-six hours.

SIR JOHN HERSCHEL ON METEOROLOGY.—In a letter to the Manchester Literary and Philosophical Society, Sir J. Herschel denies that he has abandoned the Hadleian theory of winds. He is disposed to attribute the extraordinary climatic features of the last two years to the great outbreak of solar spots in September 1859, which was associated with unprecedented magnetic disturbances. This occurred as the sun was passing southwards across the equator, and Australia experienced a summer of unusual heat. The quantity of vapour then thrown into the atmosphere from the southern ocean does not appear to have been yet got rid of.

HOMŒOPATHIC MEDICINES AND THE SPECTROSCOPE.—Dr. Ch. Ozanam states in the *British Journal of Homœopathy* that a spectroscope by Steinheil enabled him to recognize lithium in the fifth dilution of its chloruret, a drop containing 5 billionths of a milligramme. The milligramme is one thousandth of one gramme, which is a minute fraction less than 15½ grains. He detected sodium in a drop of the 6th dilution of its chloruret, which weighed 3 centigrammes, and contained three hundred billionths of a milligramme.

MARKINGS ON DIATOMS.—Professor O. N. Rood, U. S., has published in *Silliman's Journal* (Jan. 1862) some fresh investigations on the much-disputed question of diatom markings. He brings the microscope to a horizontal position, removes the mirror, and places a lamp or candle in the axis of the instrument, and not more than three inches from the stage. If a small sphere of glass is then placed in the focus of the objective the inverted image of the lamp or candle which it forms is seen in an erect position, and if a rod one-tenth of an inch in diameter is moved up and down between the sphere of glass and the light, its image is distinctly seen. "Upon replacing the sphere by a minute concave lens, as an air-bubble in water, the reverse takes place; to gain distinct vision of the flame, it becomes necessary to move the compound body within the focus: the image of the flame appears inverted, and the motion of the rod seems reversed." Having thus noticed the different action of concave and convex lenses, he experimented with the markings on *Coscinodiscus*, *Triceratium*, etc. When these objects were mounted in water, which possesses a much smaller index of refraction than the silica of which they are composed, and viewed with a power of 600 or 800 diameters, "each hexagon was found to contain a minute distinct image of the flame, the motion of the rod showed that the images were inverted, and consequently formed by *concave* lenses. When mounted in Canada balsam, which has a higher index of refraction than silica, the influence of the balsam predominates, and the action of the lens is reversed, so that the markings behave like convex glasses. Balsam of Tolu, with a still higher index of refraction, gives the same results.



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